FUNCTIONAL OUTCOME OF THE DISTAL FEMUR LOCKING COMPRESSION PLATES IN THE TREATMENT OF FRACTURES OF DISTAL FEMUR

Dissertation submitted in

Partial fulfilment of the regulations required for the award of

M.S. Degree in Orthopaedics

THE TAMIL NADU Dr M.G.R. MEDICAL UNIVERSITY

CHENNAI, TAMIL NADU

April 2015

CERTIFICATE

This is to certify that the dissertation entitled "**FUNCTIONAL OUTCOME OF THE DISTAL FEMUR LOCKING COMPRESSION PLATES IN THE TREATMENT OF FRACTURES OF DISTAL FEMUR**" is a bonafide and genuine research work Carried out by **Dr. Vijaykumar .R** in partial fulfilment of the requirement for the degree of Master of Surgery in Orthopaedics

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DECLARATION

I declare that this dissertation titled "**FUNCTIONAL OUTCOME OF THE DISTAL FEMUR LOCKING COMPRESSION PLATES IN THE TREATMENT OF FRACTURES OF DISTAL FEMUR**" has been prepared by me, at Coimbatore Medical College Hospital under the guidance of **Prof. Dr. S. Elangovan** Coimbatore Medical College Hospital, Coimbatore, in partial fulfilment of Dr. M.G.R. Tamilnadu Medical University, regulations for the award of M.S. Degree in Orthopaedics.

I have not submitted this dissertation to any other university for the award of any degree or diploma previously.

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ACKNOWLEDGEMENT

I wish to thank God Almighty for giving me the health and strength to complete this study.

It is my first duty to thank **Dr.S.REVWATHYM.D.,DGO.,DNB**, our **Dean, Coimbatore Medical College and Hospital** and **Prof.Dr.Dhandapani M.S.Ortho, D Ortho**., Professor and Head of the Department of Orthopaedicsurgery, Coimbatore Medical College and Hospital for having given me the permission to conduct this study and utilize the clinical materials of this hospital and for their valuable guidance and suggestions.

I express my gratitude to my guide , mentor and my respected chief **Prof .Dr..S.Elangovan** for his untiring help ,suggestions and guidance given at every step of this study.

I sincerely acknowledge my teacher **Prof.Dr.S.Vetrivelchezhian** and my assistant professor **Dr M.S.Muganthan Dr.K,Gajendran, Dr.P.Balamurugan, Dr.K.S.Maheswaren, Dr.S.Marimuthu** and

Dr.Major. K.Kamalnathan for their constant help, advice and guidance rendered to me in preparing this dissertation.

I am grateful to my fellow postgraduates and all the staff members of the Department who helped me in all possible ways in this study.

My sincere thanks to our operative theatre personnel and staff members of the Departments of Anaesthesiology and Radiology for their help in the study.

My sincere thanks to all my patients who cooperated with me for this study.

Last but not the least I want to thank my dear father and mother for making me what I am today and my dear wife Dr.Sridevi for her patience and support.

Dr.R.Vijaykumar

M.S.Orthopaedics postgraduate

ABSTRACT

AIMS AND OBJECTIVES

Aim of this study is to evaluate the functional outcome of the distal femur locking Compression plates in the treatment of fractures of distal femur.

OBJECTIVES

1.Whether fractures reduction and fixation with locking compression plate will give acceptable results in the distal femur fractures treated in our setup.

2. To study the clinical outcome associated with this treatment modality

3. what are the potential complication associated with the procedure

MATERIALS AND METHODS

This is a prospective ,nonrandomised observational study of 14 Patients, with distal femur fractures (Muller AOclassification type 33 A,C) who were treated with DFLCP at Department of Orthopaedics, Coimbatore medical college hospital, Coimbatore from May 2013 to September 2014. The study sample was 14 patients and all these patients were included with predefined inclusion & exclusion criteria in this study. Minimum of 6 months and a maximum of 16 months follow up was done.The functional and radiographic results were recordedaccording to Neer's criteria

RESULTS

In this study, Most of the patients in this study were old patients in the age group 50-85 yrs.In this study 53% of the cases were Muller type A and 47% were type C andfor three patients MIPPO technique was followed

In our study in most of cases long working length was followed but in four

patients short working length was used but we had no implant failure among these cases and Bone grafting was done for three patients

The shortest follow up period was 3 months and longest period was 12 months , average union time was 4 months and most common Complications is knee stiffness which wasalmost 84 % of the patients with average knee motion was 25 degree of flexion,15% of the cases got infected. Shortening seen in 21% and no cases of   implant failure in our study .

In this study by the analysis of the results two cases with excellent results, 7 cases with good results and one cases with failure result.

CONCLUSION

We conclude that DF-LCP, the “internal fixator” is a safe and reliable implant although careful preoperative planning and case selection and taking up cases for surgery as soon as possible are important factors which determine the final outcome. It may substitute a conventional plate and screw system(compression method) in treatment of complex distal femoral fractures especially in osteoporotic bone.Asour study was limited by its small sample size and time duration sofurther randomised controlled studies are required in different situations to know the usefulness of this implant.

Key words: Neer’s criteria,DF-LCP,knee stiffness

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ETHICS COMMITTEE

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Course : M.S ORTHOPAEDICS

Period of Study : 2013 - 2015

College : COIMBATORE MEDICAL COLLEGE

Dissertation Topic : FUNCTIONAL OUTCOME OF DISTAL FEMUR LOCKING COMPRESSION PLATE IN THE TREATMENT OF FRACTURES OF DISTAL FEMUR

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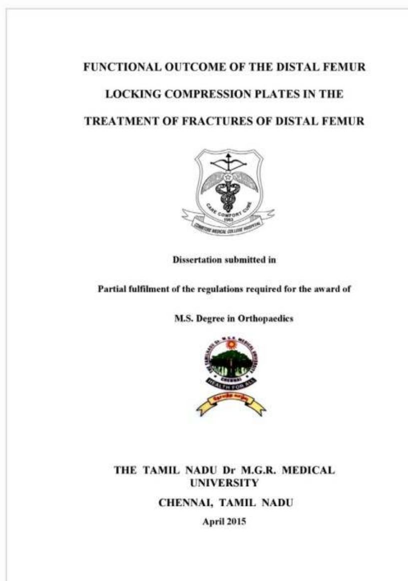
Submission title:	FUNCTIONAL OUTCOME OF THE D.
File name:	Full_Thesis.docx
File size:	1.04M
Page count:	124
Word count:	14,032
Character count:	75,889
Submission date:	30-Sep-2014 12:35PM
Submission ID:	453432736



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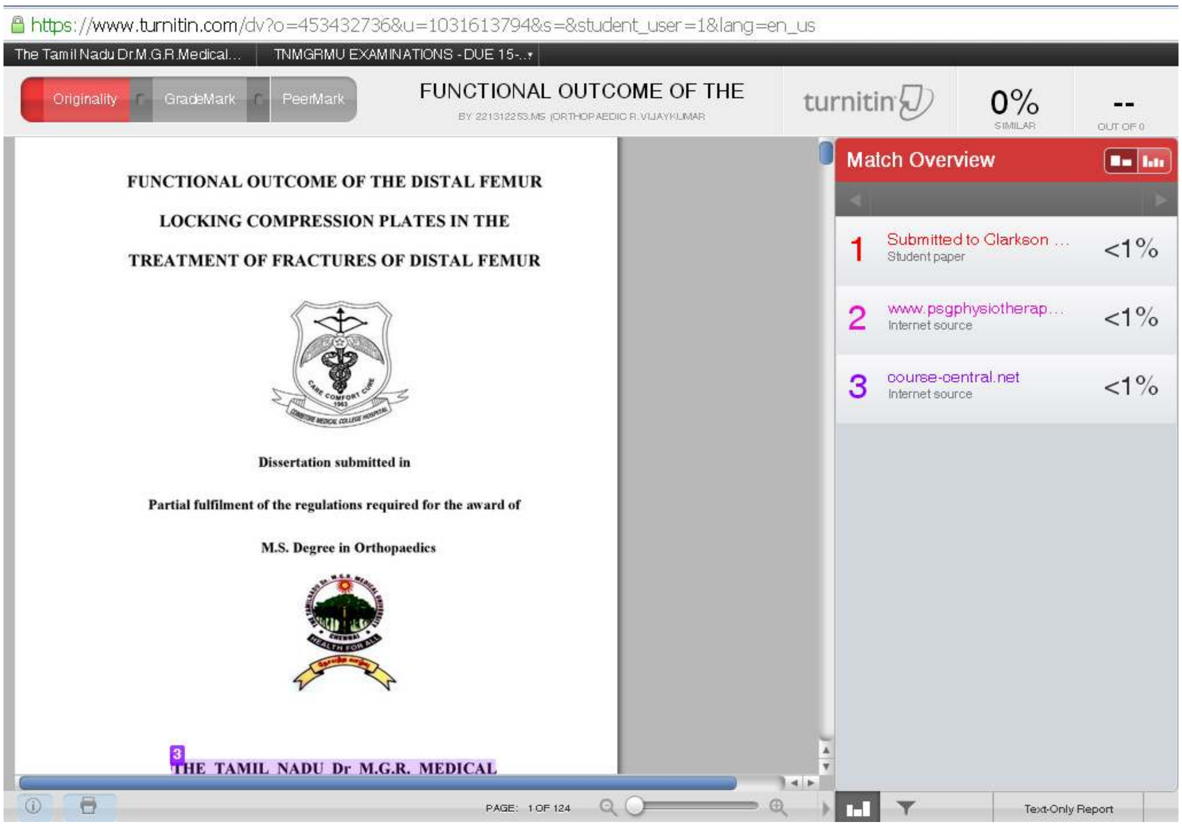
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Text-Only Report

INTRODUCTION

In the last few decades, rapid industrialization and the changes in lifestyle of people have brought catastrophe like road traffic accidents has crippled many young productive lives.

Distal femoral fractures account for 6 % of all femoral fractures. And these fractures have a bimodal pattern that is in younger patients they occur as a result of high energy but in older osteoporotic individuals with weaker bones due to just trivial fall .

The treatment of fractures of this region has passed through different phases from total conservative management to the present day minimally invasive fixations.

"Few injuries present more difficult problems than those associated with Supracondylar and Intercondylar fractures of femur"

-Sir Reginald Watson Jones

"No category of fracture at this level seemed well suited for internal fixation ,and sufficient fixation to eliminate the need for external support or to shorten convalescent was rarely attained"

-Neer et al

Both statement mentioned above focuses on complexity while treating these fractures.

In early 20^{th} part of century when closed reduction technique of Watson jones and Sir John charnley were followed it ledto stiffness, angular deformity ,limb length discrepancy.

So when these fractures were managed with closedconservative method with traction, casting, or both then problem which we faced were capsular contraction of the knee joint and fibrosis of the muscles around the knee joint and mainly failure to maintain reduction if achieved and associated medicalcomplications of prolonged immobilisation specially in gediatric patients, Apart from the fracture, the time spent in traction caused economic problems of increased hospital stay for the patients.

The poor results after conservative treatment and with advent of plates in the early 1930, madesurgeons to indulge in surgical management of the these fractures butdue toinadequacies in asepsis and non-availability of antibiotics,the above fixations got infected .Following this there was widespread reverting of treatment of supracondylar fractures back to conservative methods.

With theadvent of prophylactic antibiotics, proper theatre sterilisation, strong plates which can be used with minimal dissection of tissues and the when concept of biological plating ie minimally invasive plate osteosynthesis (MIPO) 2 and the less invasive stabilisation system (LISS) which is based on the MIPO technique have revolutionised the management of distal femoral fractures.

These fracture need to be rigidly fixed to allow early mobilisation of the knee. Any method of strong biological fixation after anatomical reduction is expected to achieve good results. and However, as the complexity of fractures is increased then other implants may not be ideal and biomechanical studies has shown that condylar buttress plates or dynamic condylar screw fixation.are inferior to the LISS as it has more angular stability and better remodelling potential so the treatment of fracture of this region has passed through phases from total conservation to the present day minimally invasive fixation at present there is only controversy in deciding the type of fixation which is appropriate for the given fracture pattern, so the purpose of this study is to evaluate the functional outcome of distal femur fractures treated by locking compression plate.

AIM OF THE STUDY

Aim of this study is to evaluate the functional outcome of the distal femur locking Compression plates in the treatment of fractures of distal femur.

REVIEW OF LITERATURE

Literature review is incomplete without going through the history, so first we would like to discuss about the history first then about the study and by going through the history we can know how treatment modality has evolved with the passage of time

HISTORICAL REVIEW

History is very important to any surgeon, particularly the Orthopaedic surgeon. The Orthopaedic surgeon has been presented with advancing technology with time and the surgeon should have basicunderlying knowledge of the history of his art and principles and he must be aware of the way the surgeons in the past have contributed to Orthopaedics and more importantly, of the mistakes that they have made in the process.

“It has been well said that those who failed to study history are destined to commit the mistakes again”

Ancient Indians have practiced treatment of fractures with immemorial variety of methods like bamboo sticks, variety of resins and lime which attain hard consistency on drying like modern POP, and it is well documented in ATHARWAVEDA about 2000 BC, and later by SAMHITAS of CHARAK about 1000 years BC.

And we all very well know that the management of fractures has changed very much over time. It has advanced from bamboo stick, POP to modern minimally invasive surgeries, to Robotic and Computer Navigated and assisted surgeries.

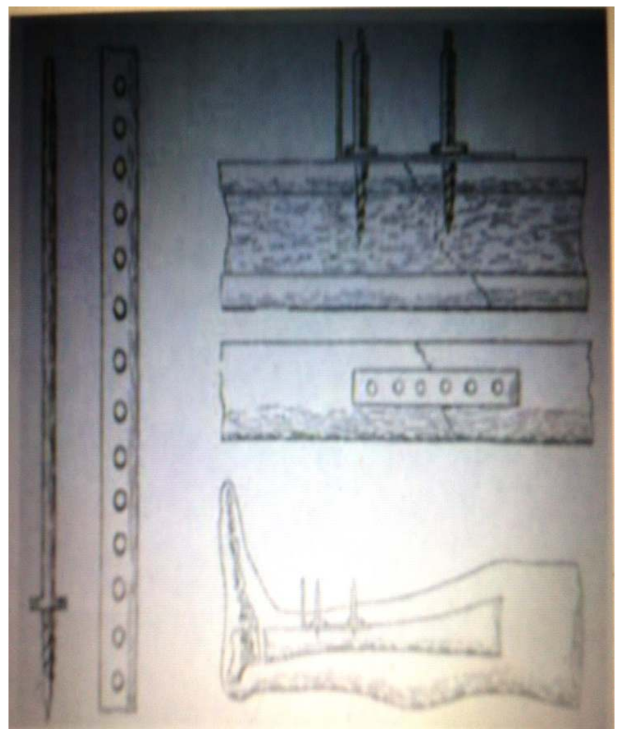
The surgical management of not only femur but any long bone fractures was revolutionised during the world war period so the world war which was curse to mankind but it contributed blessings to orthopaedics speciality.

The major advances in the treatment of all types of femoral fractures were first seenwhen in 1870 when **Hugh Owen Thomas**[8] devised the “Thomas Splint”.

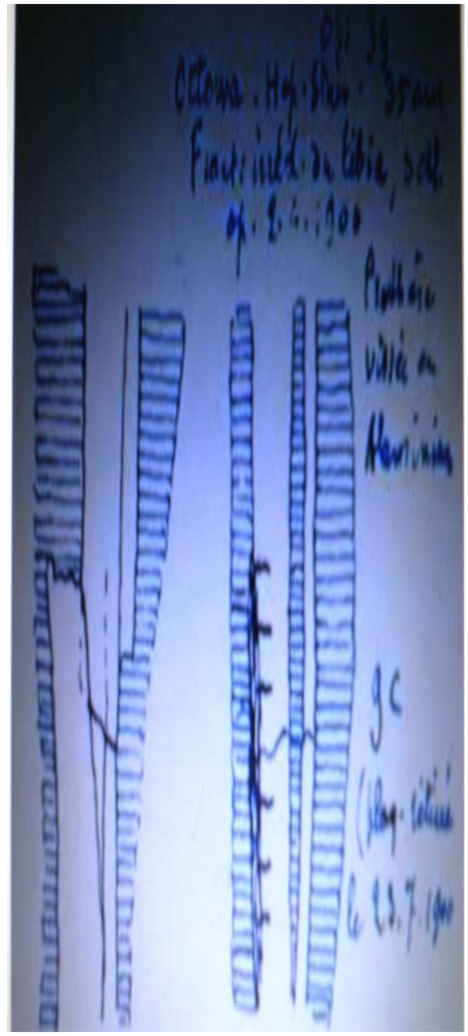
Percival pott proposed that fractures should be immobilized in a position that relaxed the surrounding muscles which produced forces that deform the fracture In **1861, Buck** introduced Skin traction for femoral fractures

In **1907 fritz Steinmann**[8]and**Kirschner in1909**described techniques for applying Single pin traction for femoral fractures replacing the skin traction.

At the end of the 19th century C. Hansmann from Hamburg, Germany developed the plate osteosynthesis



And he is nowadays considered as the pioneer of plate osteosynthesis. In his publication he presented his method for fracture fixation by plate. Which is shown in above picture

AlbinLambotte a Belgian surgeon created the term ‘osteosynthesis’andbrought forward the concept of internal and external ‘splinting’. Today, these principles are still used in almost all modern stabilisation methods. Apart from the external fixator, he developed many different plate and screw designs, which made anatomical reconstruction and early mobilisation of the limb and the patient possible

AlbinLambotte (1866-1955)[28] who defined the term osteosynthesis. To the right side: A drawing of the treatment of a non reducedtibial shaft fracture by using a plate

And when **James E Anderson**[61] described the anatomy of lower end of femur it helped us to know more about surgical approach.

In**1921Russell** combined skin traction with positioning of hip and knee in flexion.

In **1929, Bohler** of Austria developed a special stirrup that could be attached to the Steinmann pin and helped in varying the direction of traction without rotating the pin in the bone which helped in conservative management.He claimed to have been able to successfully control fracture position in 100 cases that he personally treated[63]

And when internal fixation using metal implants were going on then in early 1930s **Venable and Struck** [9] described chromium molybdenum and nickel-vitallium inert alloys which helped in developing biocompatible implant.

Mahorner and Bradburn in 1933, reported the results of treatment of 308 femoral fractures. The best results were obtained after skeletal traction, although fracturesof the distal femur had poorer results than shaft fractures.

In 1937 Tees[62] discussed the difficulty encountered in management of supracondylar femoral fractures because of limited control of the distal fragment In **1945, Modlin**[10] reported 23 fractures of distal femur treated by skeletal traction. He inserted one Kirschner wire in the distal femoral fragment and one in proximal tibia. He reported fairly acceptable alignment with minimal incidence of sagging, good results were obtained by this method.

Robert Danis Belgiansurgeon, who is considered as the '**Father of the modernOsteosynthesis**. In 1947 when he published the development of a special compression plate which permitted immediate mobilisation after fracture stabilisation .With this kind of fracture fixation with axial compression and rigid fixation the fractures healed without radiological signs of callus formation. He described this finding as 'primary fracture healing', in contrast to the 'secondary fracture healing' with callus formation by conservative treatment. This conclusion led to the opinion that callus healing was connected to instability with the associated tendency to develop delayed or nonunionsor risk of implant failure

In **1951 Hampton**[10]in his book "Wounds of Extremities in Military Surgery" reported good results with skeletal traction. He used suspended traction system mode of Thomas splint with Pearson attachment and emphasized the importance of early active exercises and high protein diet and frequent Roentgenographic examination during recumbent period.
In **1953, Wiggins**[10]reproduced the results of Modlin using two pin skeletal traction system.

In **1955, Sir Reginald Watson Jones**[4]noted warned the surgeon 5 against any attempt at knee motion in less than 6 weeks and even quadriceps exercises were contraindicated, lest the fragment redisplaced in management of supracondylar fractures.

In **1956, White and Russin**[10] published an encouraging report on 46 fractures,which were treated by ORIF using Reverse-Blount plate supplemented with additional plate and screws. They condemned the then conventional method of traction and immobilization.

And in same year **Edgar et al**described a series in which 47 patients were treated by internal fixation and immediate knee motion. They reported that poor results were due to errors in the surgical judgment rather than failure of the method of treatment.

In 1961, John Charnley[5] in his monograph, "The Closed Treatment of Common Fractures" devoted a chapter on fracture of femoral condyles. He described in detail the technique of applying skin traction under anaesthesia to the leg and immobilization in Thomas Splint. He also advocated the principle of controlled collapse at the fracture site. He advocated operative treatment for fractures in athletic patient and where fracture fragments were held apart.

In 1965, Bank[11] demonstrated that accurate opposition and rigidimmobilization was necessary for adequate healing in intra-articular fractures. He showed that devitalized free fragments in intra-articular fractures had no potential for callus formation.

In 1958, the Swiss AO Group was formed, thus commencing a new era in fracture care. Their desire was to restore full function to the limb and to avoid fracture disease associated with prolonged immobilization and they recommended the principles of anatomic reduction of the fracture fragments, preservation of the blood supply and standardised the use of plate systems. They described the main goals of fracture treatment in the first edition of the'AO Manual of Internal Fixation' in 1965 [21]as the restoration of the function of the injured limb.

Through performing a stable osteosynthesis, the bone should get the primary strength to recover by early functional aftercare.

This could be achieved by a conventional, open surgical approach for visualisation of the fracture site, open reduction of the fragments and stabilisation of the reduced fracture with a plate, so called open reduction and internal fixation(ORIF).Complications such as wound and bone infections (by large approaches and wide dissections of the bone malalignments and fracture disease caused by long term immobilisation of the limb and the patient should be avoided. To reach this goal, four fundamentals were set in the AO Manual [72]

The principles are

1.Anatomical reduction

2.Absolute stability with interfragmentary compression

3.Preserving blood supply throughoutatraumatic operation technique

4. Avoiding additional damage by immobilisation

One of the earliest reference regarding the fractures of distal femur was found by **Stewart et al [10] in 1966** in their landmark study compared 442 patients who had received treatment for fracture of distal third femur during 20 years in the Campbell Clinic. They advocated 2 pin traction using 3/32 inch smooth Kirschner wires with spreaders as the treatment of choice. They condemned most of the then popular surgical techniques. They had 67% good results with closed methods ascompared to 54% with open reduction and internal fixation techniques and they concluded that conservative method of management gives universally good results in supracondylar femur and distal third fractures.[6]

In **1967, Neer et al** [12]analyzed the results of internal fixation in cases of supracondylar fractures of femur as compared to those of closed methods of treatment. They classified this fracture according to displacement of condyles in relation to shaft of femur. They studied 110 cases of supracondylar fractures of femur out of which 29 were treated by open reduction and internal fixation and rest were treated by closed methods. They reported only 52% satisfactory results with operative method while 90% satisfactory results with closed method. They also obtained satisfactory results in 84% of displaced supracondylar fractures. Neer et al formulated a rating system based on points given to functional and anatomical criteria. This rating system is followed by many and is recommended specifically for evaluating distal third fractures.

Then **Radolph and Anderson** [13] reported on the series of 56 cases of fracture shaft femur, 20 of which were in distal third and included supracondylar fractures of femur. He showed good results with conservative treatment by Russel traction. He paid particular attention to find length and alignment and achieved nearly 120º of knee flexion in most of his distal femoral fractures.

With the advent of AO methods, there was flurry of publications demonstrating surgical techniques of open reduction internal fixation of supracondylar fractures of femur but the technique however, remained complex and required experience.

In 1971 Slatis and associates treated 21 patients with supracondylar fracture according to the AO method and in follow up study they found 83% had good to excellent results.and recommended the technique as "reliable" but stated that it "should be restricted to fractures of considerable severity and to selected cases among patients with multiple injuries"[62]

In the period of **1965-70, Sven Olerud**[15] studied 15 cases of 7 supracondylar fracture femur treated by AO technique. AO blade plate fixation was done. Good to excellent results were obtained in 14 cases. He advocated extensive exposure of the fracture by removing tibial tuberosity as a bone block by reflecting the entire extensor mechanism proximally. He was able to achieve stable anatomical reduction of intraarticular fracture by this method. However, 4 patients in this series developed infection, so he advocated caution in the use of this extensive approach.

In **1972, Enneking et al** [17] studied the intra-articular effect of prolonged immobilization on human knee. They reported that, long-term immobilization causes progressive capsular and pericapsular contractures with fibro fatty infiltration of the joint by adhesion and play an important role in the clinically stiff knee.

In **1973, Connoley JF**[18] in their in vivo quantitative analysis measured axial rotation and translation of the fragments in 30 patients with distal third fractures of femur while in bed (in traction) and while they walked in cast brace. They observed rotation in bed was less in cast brace than in traction or suspension and translation during weight bearing in cast brace was least in supracondylar fractures of femur.

They concluded that closed reduction and early ambulation in a cast brace are best studied for fractures in distal third of the femur and comminuted fractures of proximal 8 femur. They described the greatest advantage of immediate cast bracing was its effect on the entire patient and not just on the fracture.

As surgical procedures were gaining popularity, postoperative infections remained a major concern to all surgeons. To overcome this, concept of prophylactic antibiotics evolved and many reported favourable effects.

In **1974, Alan Pavelet al**[19] advocated the concept of prophylactic antibiotic administration and obtained favourable results. The antibiotic of choice was cephalosporin given one hour preoperative,intraoperatively and then postoperatively in patients who were to have surgical time exceeding 30 minutes. Infection rate dropped to 2% with their prophylactic regimen as against 5% who received a placebo.

In 1974, Schatzker et al [20] published a paper in which study period wasfrom 1966 to 1972. In which They treated according to AO principles they treated fractures and found that 75% had good to excellent results. This study clearly demonstrated the superiority of AO methods not only as a surgical technique but as a method of choice because the Toronto surgeons were not the members of Swiss AO group but still could obtain comparable results with AO principles.

As infection was being tackled with the use of asepsis and antibiotics and surgery was gaining acclaim, postoperative knee stiffness posed a common problem after surgery . In an effort to overcome stiffness of knee, the use of **continued passive movement was advocated byWiroon and Stills** and they stated that acute reaction of traumatized tissue subside in about 3 days and continued passive movement applied for this period might be enough. Three days of continued passive movement improves joint mobility and histologically enhances the healing of articular cartilage.

In **1982, Lars Kolmert&KrisierWulff**[24] conducted an epidemiological study of distal femoral fractures in adults,out of 135 patients with 137 fractures, 47 fractures were treated non-surgically and rest 90 were treated surgically using AO blade plate, Rush Pins and Cancellous screws. Of the surgically treated patients, the authors reported unsatisfactory result in the elderly age group. Complications in elderly group were implant breakage or cutout of implant with resulting malposition or failure of osteosynthesis.

In the sameyear ,**RD Mize et al** [25] in their study of 30 supracondylar and intercondylar fractures reported good to excellent results in 24 patients. They treated the fracture using the extensile approach described by Sven Olerud and the use of AO blade plate for fixation. They advocated that the advanced age of the patients should 10 not be contraindication to open reduction and internal fixation. They obtained good results in elderly patient treated operatively in their series.

In 1990, Yang et al[27] evaluated 93 patients with supracondylar and intercondylar fractures. Open reduction internal fixation was done in all patients using 95º angled blade plate and results were evaluated by Shelbourne and Brueckmann's criteria. 61.3% patients were rated as excellent and 23% as good results. Emphasis was laid on early postoperative knee mobilization.

In **1991, Roy Sanders et al**[28] described the treatment of comminuted and unstable fractures of distal femur using double plating i.e. medial and lateral condylar Buttress plate were used, however, the postoperative knee range of movement was unsatisfactory.

In 1992, Shewring DJ et al[29] used the AO DCS and side plate assembly in 21 cases of supracondylar and intercondylar fractures of femur. They ratified the efficiency of this implant system and described it as "Effective and technically undemanding method" of treating supracondylar and intercondylar fractures of femur.Good results were obtained in all but one of their case series.

In1995, M S Butt et al[30]conducted prospective,randomised controlled trial in which 42 displaced fractures of the distal femur in elderly patients were studied . Excellent or good results were achieved in 53% of the operated group and in 31% of the non-operated group and among which complication were more in nonoperated group.

In 1997 C Krettek et al [31] suggested that byusing the TARPO/MIPPO technique for the treatment of complex supracondylar femoral fractures it gives favourable results as compared tolateral approach with the added advantages of a faster rate union, no need for bone grafting, and improved exposure of the knee joint due to decreased iatrogenic disruption of the metaphyseal blood supply healing is improved.

In 1998 P Guy et al[32] conducted CT analysis of femur and mentioned that The DCS screw "insertion point" and its length to be within the prescribed rangeshould be well planned and In addition, the specific relationships between the distal and proximal segments of the femur facilitate the reduction in both plane .

In2000 O Martinet et al[1] studied the two different aspects in the aetiology of the distal femur fractures they mentioned that fractures due to high energy trauma (traffic or sport) are sustained by young people, mainly men [12](although women are also affected), or fractures of bones degraded by osteoporosis, mainly elderly women.

In 2000 A Maier et al[33] studied on the femur cadaver specimens and introduced 3rd method of insertion of screw in DCS. (Two methods described by AO). They advocated insertion in lateral aspect at junction of anterior 1/4 and posterio3/4 rather than 1/3 and 2/3 junction as advocated in AO trauma manual

In 2001 Kregor et al 34 shown that the for treatment of distal femur fractures using liss fixator, which has similar material and design characteristics as the LISS fixator used for tibia , it provides superior fixation in osteoporotic bone compared with the blade plate and retrograde IM nail and also shown that its use prevents varus collapse in bicondylartibial plateau fractures.

In 2001 Schandelmaieret al[35] studied the advantages of LISS in 40 patients of distal femur fractures.The advantages of the LISS over conventional plating are a shorter healing time and a reduced need for bone grafting. Compared with the DCS,the LISS represents an improvement of percutaneous techniques.

In 2001 Marti et al [36]compared the dynamic condylar screw and condylar buttress plate to the LISS platein a cadaveric model. And showed that LISS is more superior with respect of deforming forces when applied as compared to the other two constructs, which they attributed to the titanium composition and the unicortical screws.

In 2003 Sommer et al didthere first clinical study, in which they treated 169 patients using LCP, and concluded that the new system is technically superior to other method of fixations as majority of patients as excellent results.

In 2003 Karl Stoffel et al[37]recommended that for femoral and tibial fractures, two or three screws should be placed on either side of the fracture and loaded in compression mode . and the size of fracture gap determine the position of the first screw near the fracture and further additional screw placement depends on the fact that if gap [13]is smaller than 2 mm, one or two holes near the fracture in case of simple fracture can be omitted so that micro motion and bone contact to occur but In case of comminuted fractures three screws on either side of the fragment with twoscrews as close as practicable to the fracture site should be applied.

In 2004 mark et al concluded that LISS allows stable fixation and facilitates early healing in mechanically unstable fractures of distal femur.

In 2004 Kenneth A. Egol et al [7] conducted a study on Biomechanics of Locked Plates and Screws and showed that there is completely different mechanical principles for LCP and conventional plate to provide fracture fixation .

Man-Kwan Wong et al 2005 (International Orthopaedics (SICOT) (2005) concluded that LISS is an effective way to treat distal femoral fractures older patientsand. Special precautions should be taken in these patients and when secure fixation is questionable then usage of longer plate or bicortical screw fixation is recommended

In 2006 Zlowodzki et al 40 combined the series of 327 patients with fracture distal end of femur and evaluated the outcomes as part of a systematic literature review.and studied the complication and showed that.technical errors [14] that have been reported for fixation failure are waiting too long to bone graft defects, allowing early weight bearing, and placing the plate too anterior on the femoral shaft.

In 2006 Vallier et al [41] concluded that locking plates should only be used when conventional fixed-angle devices cannot be placed and to decrease the risk of implant failure , accurate fracture reduction and fixation along with judicious bone grafting, protected weight bearing, and modifications of the implant design were recommended.

In 2007 P Kanabar et al studied that LISS plating is useful in treating complex distal femoral fractures. In which they found that in osteoporotic patients.Bicortical screws give better fixation. Large studies from independent centres reporting long-term results are needed to conclude that LISS plating is better in the management of complex distal femoral fractures.

In 2007 EjYeap et al concluded that lcp is good implant for use in distal femur and they recommended this implant in type a,costeoporotic and periprosthetic fracture.

In 2007 M. Ahmad et al[42] studied on biomechanics of locking compression plate.Consistent results were achieved in LCP constructs in which the plate was applied at or less than 2mm from the bone. When applied 5mm from the bone the LCP demonstrated significantly increased plastic deformation during cyclical compression and required lower loads to induce construct failure.

In 2007 Higgins et al[43]in a cadaveric studies compared the Locking Condylar Plate with distal locking screw fixation and bicortical locking and nonlocking diaphyseal fixation, and found that locking construct had a significantly higher load to failure and less permanent deformation with cyclic loading. All of these studies reveal that locking plates with unicortical or bicortical diaphyseal fixation have adequate axial stiffness but differs in the flexibility when compared to conventional fixed-angle implants.and the studies that evaluated torsional stiffness have shown that the distal fixation in locked implants is maintained but in case of conventional fixed-angle implants they have a higher rate of distal cutout from the femoral condyles.

In 2010 F. Winston Gwathmey et alexplained the current concepts in distal femoral fractures and concluded that fractures of the distal femur present treatment challenges.[71] because of the inherent complexity of the injury as well as the internal and external deforming forces that act on fixation. Management priorities include restoration of the articular surface as well as length, rotation, and alignment of the distal femur. Locked plating and IM nailing are mainstays of surgical treatment because of their ability to obtain sturdy fixation,even in osteoporotic bone, and their resistance to inherent deforming forces

In 2010 Christopher E Henderson et al[44] concluded that with use of locking plates to fix distal femur fractures there is no evidence demonstrating that these devices are superior to previously established methods and found no observed differences in the rate of nonunion, infection, fixation failure.

In 2010 Drew et al[45] studied the use of allograft osteochondral graft in repair of distal femur fractures.

In same year **VallesJF,RodríguezFR,Gómez JM**, Patients with distal femur Fracturestreated surgically between January 2007 and December 2009 were assessedretrospectively. They concluded that the patients with fracture of the Distalthird of thefemurmanaged with a minimally invasive stabilization system had better outcomes,which werenot significant in the Neer scale, mainly due to less pain intensity, earlymobilization and less functional repercussions.[68]

In 2011 Christopher et al[46] studied that with the use of locking plates to fix distal femur fractures and found that these devices are superior to previously established methods but subgroup analysis suggested that there is increased risk of locking plates failure compared to conventional plates but ainfection rate is reduced.

In 2010 Michael Bottlang et al studied about callus formation with locked plating constructs . By providing flexible fixation and nearly parallel interfragmentary motion, far cortical locking constructs form more callus and heal to be stronger in torsion than locked plating constructs. Far cortical locking fixation may be advisable for stiffness reduction of locked.[69]

In 2010 Kim KJ et al concluded that internal fixation using locking compression plate for AO type C distal femoral fractures provided excellent fixation.[70]

In 2011 Manohar G et al studied about functional outcome following ORIF of supracondylar intercondylar fracture femur and they concluded the results were better in young patients and when it was performed early.

In 2011 Christian et al [47] concluded both retrograde IM nailing and LISS plating may be adequate treatment options for distal femur fractures. No differences16in outcome between implants regarding fracture healing, nonunion, and infection were found. Locked plating may be utilized for all distal femur fractures including complex type C fractures, periprosthetic fractures, as well as osteoporotic fractures. IM nailing may provide favorable IM stability, may promote formation of circular and stable callus, and may be successfully implanted in bilateral or multisegmental fractures of the lower extremity as well as in extra-articular and type C1 fractures. However, both systems require precise preoperative planning and advanced surgical experience to reduce the risk of revision surgery. Clinical outcome may largely depend on surgical technique and rather than on the choice of implant and multicenter studies with high numbers of patients are required to draw useful conclusions.

In 2011 Doshi et al (Geriatric Orthopaedic Surgery & Rehabilitation journal) 2013- The MIPO technique combined with distal femur locking plates in small older adults were studied and found that . The technique appears to be useful and safe. All patients treated with this technique healed and had satisfactory functional outcomes However, a 20% incidence of DVT was noted and suggests the need for routine chemoprophylaxis therapy in this elderly patients with distal femur fracture.

In 2011 Ravi M Nayak et al evaluated treatment outcomes ofminimally invasive plate osteosynthesis (MIPO) fordistal femoral fractures in 31 patients and they concluded that MIPO using a LCP achieves favourable biological fixation for distal femoral fractures with few complications. Bone grafting is not needed even in cases of metaphyseal comminution. Proper patient selection and preoperative planning are essential to prevent complications. The use of ≥3 locking screws is preferable in osteoporotic bone

YangTenghenget al in 2011, discussed the clinical value of treatment of the distal femur fractures with using LCP.35 patients were followed up from 8 to 24 months. The results were excellent in 23 cases, good in 9 cases, moderate in 3 cases according to Merchan standard, in which showed that the excellent and good rate was 91.4%. and Concluded that LCP for treating distal femur fractures is a stable fixation which can promote growth of bone and decrease infection.

In 2012 Aziz, et al studied about the less invasive stabilisation system (liss) plate in the treatment of distal femoral fractures and they observed an overall success rate of 75% as fractures reached radiological union within an average of 14.7 weeks. Interestingly, despite a greater mean ISS score and operating time among Type 33C fractures, the subgroup analysis confirmed that the LISS plate is a robust treatment option across all fracture severities[73]

In same year **Roberto'toole et al** studied Periarticular fractures of the knee ,particularly in the osteopenic patient and concluded that LISS is a tool with significant promise for improving the care of these fractures .

ANATOMY OF THE DISTAL FEMUR

The distal femur is the region between the femoral condyles and the junction of the metaphysis with the shaft of femur and where the femur flares into two curved condyles. The anterior surface between the two condyles has articulation for patella and the posterior surface is separated by a deep intercondylar notch.

The lateral condyle is broader than the medial and projects forward which helps to stabilize the patella. The medial condyle is longer than the lateral and extends farther distally and is convex medially.

The lateral condyle is flat and less prominent, more massive, more in direct line with the femoral shaft, hence transmits more body weight to the tibia. Its most prominent point is the lateral epicondyle where the fibular collateral ligament is attached. Just above this an impression gives attachment to the lateral head of the gastrocnemius. A short groove separates the lateral epicondyle posteriorly from the articular margin and it has a separate groove for the attachment of the muscle popliteus.

The medial condyle is long when compared to the lateral condyle[24]. It extends further inferiorly. Its medial surface is convex and is called the medial epicondyle which gives attachment to the tibial collateral ligament. The uppermost part of the condyle is called the adductor tubercle where the tendon of adductor longus gets inserted.

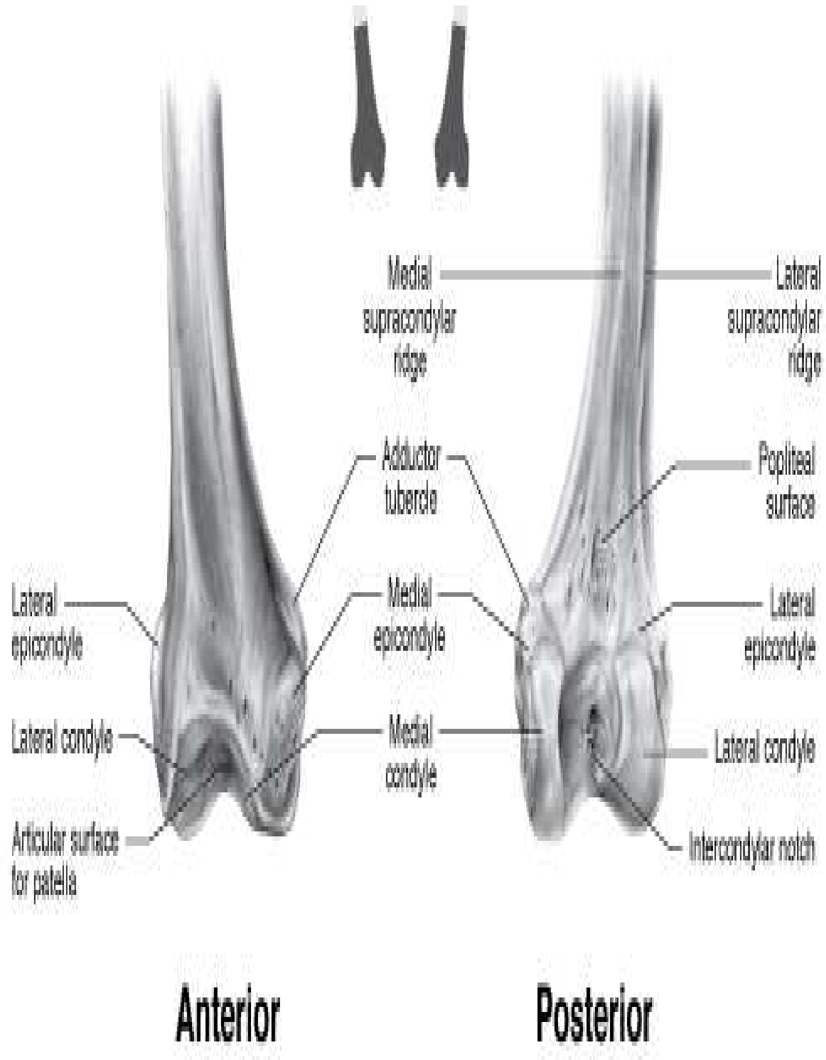


Fig1: The anterior and posterior surfaces of the distal femur

BLOOD SUPPLY OF THE DISTAL FEMUR

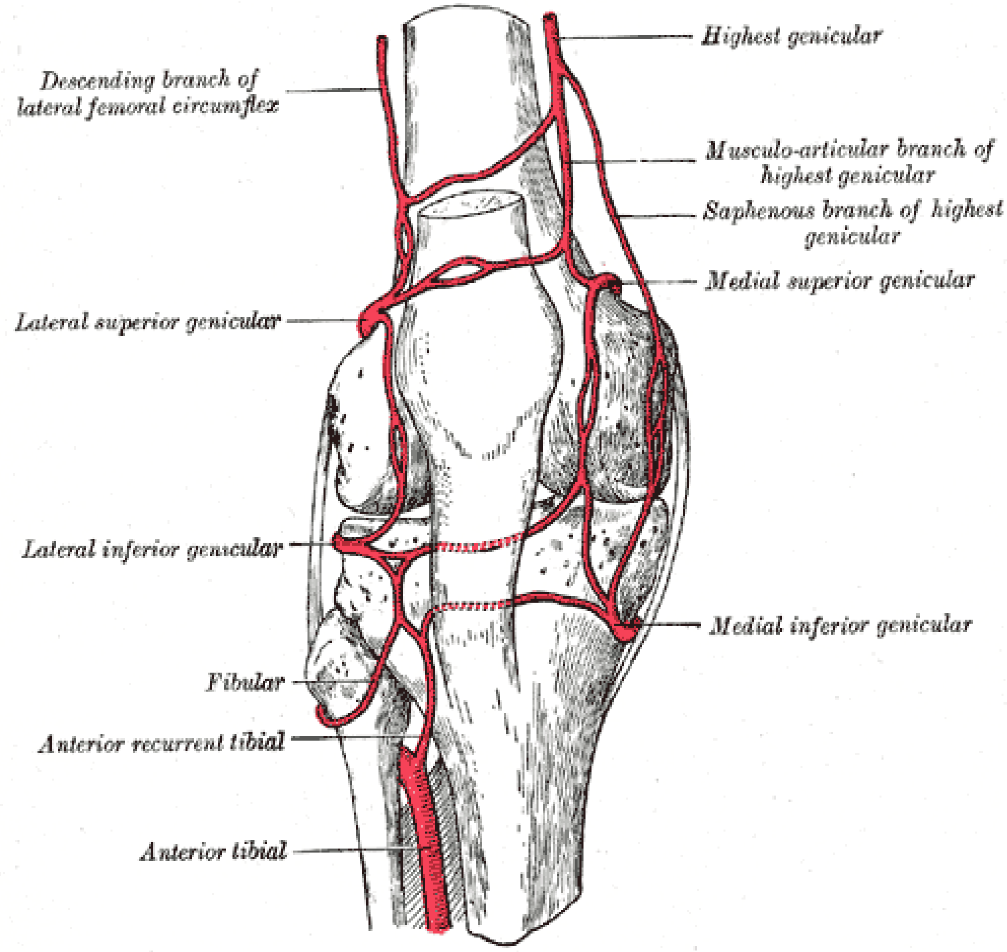


Fig 2: Vasculature of the lower femur

It is mainly supplied by the profundafemoris artery via a nutrient artery (sometimes two) which is a branch of the second perforating artery. After penetration of the posterior cortex, the nutrient artery extensively branches both proximally and distally so as to give endosteal blood supply to the shaft. The periosteal vessels which enter the bone along the lineaaspera supply the outer one-fourth of the cortex which are aligned perpendicular to the cortical surface with few branches traversing the periosteum longitudinally.

The major source for bone healing.is the periosteal vessels proliferation and these periosteal vessels supply the outer half of the cortex.

As the healing process proceeds the medullary blood supply is slowly restored. The genicular circulation is responsible for virtually all structures around the knee. This genicular anastomosis is formed by

1. Descending genicular artery, a branch of femoral artery
2. Medial and lateral superior genicular arteries, branches of the popliteal artery
3. Middle genicular artery, a branch of the popliteal artery
4. Branches of the anterior tibial recurrent arteries

The lateral femoral circumflex and the recurrent tibialis anterior arteries are additional sources of this anastomotic ring.

OSSIFICATION

Apart from the clavicle, the femur is the 1^{st} long bone in the body to ossify. The femur ossification occurs from 1 primary and 4 secondary centres. Appearance of the primary centre for shaft is in the 7^{th} week of intrauterine life. The secondary centre for the distal femur appears at the end of the 9^{th} week.

BIOMECHANICS OF THE KNEE

ALIGNMENT OF LOWER EXTREMITY

The anatomical axis is 9º valgus to the knee. The expanded femoral condyles and the corresponding tibial condyles are evolved for the direct downward transmission of load. During weight bearing the two femoral condyles rest on the horizontal plane of both the tibial condyles and the shaft of femur inclines downwards and inwards. The longitudinal axis of the diaphysis of the femur inclines medially downward, with an angle of 9º from the vertical. The mechanical axis of the femur is formed by a line between the centres of the hip and knee joint about 3 degree from the vertical (Fig 3b).

The transverse line drawn along the knee joint is parallel to the ankle or the ground knee joint axis is parallel to the ground.

Therefore the long axis of the shaft of femur is inclined at an angle to the long axis of the shaft of tibia. This tibiofemoral shaft angle is called physiological valgus.

In the sagittal plane, the femoral condyles have a changing radius which decreases from before back. In the transverse plane the condyles diverge from before back by an angle of 20º.

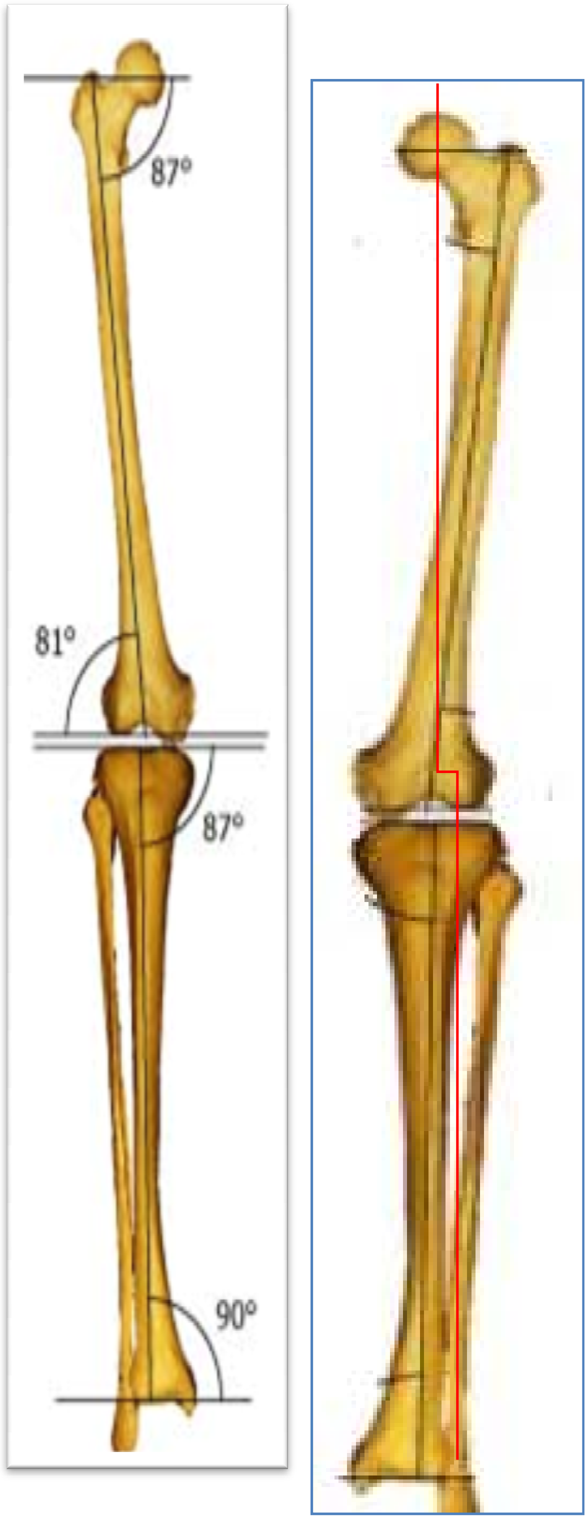


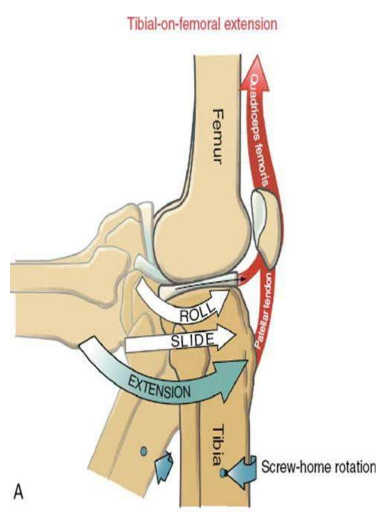
Fig 3 : mechanical axis and anatomical axis of the lower limb. The red line in 3b shows the mechanical axis.

.

The axis at which flexion and extension occurs shift backwards in relation to tibia with increasing flexion, however it lies approximately along the line joining the femoral epicondyles.

RANGE OF MOTION

The knee joint is both a hinge and a pivot joint.The full range of motion of knee extends from 10 degree extension to 130 degree flexion.and Flexion and extension involve both rolling and sliding motions. Instant center of rotation follows a J shape in the femoral condyle and it moves posteriorly with increase in range of flexion.The complete flexion-extension motionis a rocking and gliding movement (Fig 4). During rotatory motion a smaller arc is described by the medial condyle when compared to the lateral condyle. The attachment of popliteus to the lateral femoral condyle finishes the screw home movement.



Rolling and Sliding motion

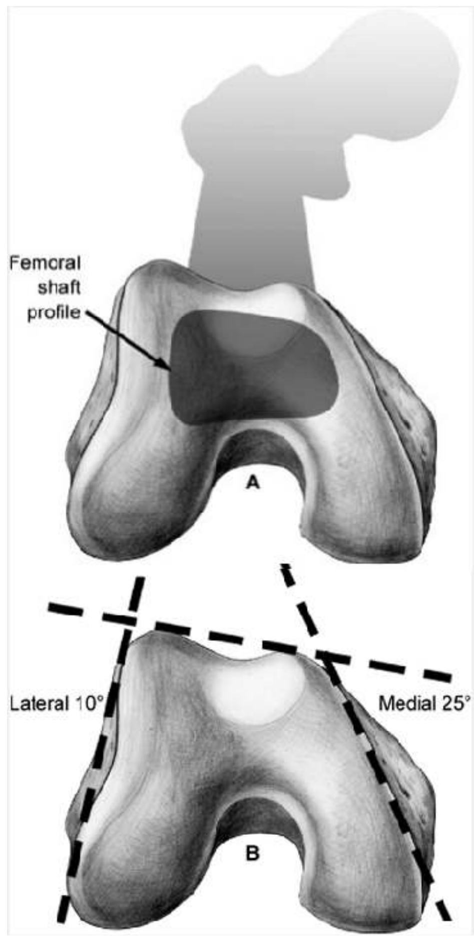
SCREW HOME MECHANISM

Femur rotates internally during last 15 degrees of extension or tibia rotates externally.Rotation in full extension is minimal and at 90 degree of flexion, there is 45 degrees of external rotation and 30 degrees of internal rotation. Abduction and adduction areminimal at 30 degrees flexion.

At the knee joint the tibia has a natural valgus on the femur and this produces greaterweight bearing stresses on the lateral femoralcondyle when compared with medial femoral condyle,Because the medial femoral condyle is more long forward than the lateral, the vertical axis of rotation of the knee falls in a spot nearer to the medial femoral condyle.[24]

The medial and lateral condyles have different structural properties. The lateral condyle is broaderin the anteroposterior and transverse planes and the medial femoral condyle projects distally to alevel slightly lower than the lateral condyle. The distal projection helps to compensate for theinclination of the mechanical axis in erect position, so that the transverse axis is horizontal. [24]

Viewed in cross section the distal femuris trapezoid in shape with the medial condyle incline at angle of25 deg and the lateral side about 10 deg (Fig 5). The posterior diameter is more than the anterior therefore the screw which appears to be of correct length in the AP Xray .



The anterior surface slopes downwards to the medial side and corresponds in inclination to the patellofemoral joint.[25] When the distal femur is viewed from the side, the condyles appear to have been added posteriorly to the shaft [25]therefore from the above discussion it is obvious that the surgical anatomy of the distal femur is complex and can present a serious problem to the surgeon who is unaware of this and for any internal fixation device it must be applied to the middle of the anterior half of the condyles. The femur is the longest bone in the human body and can bearloads of considerable magnitude. When the structural integrity of the femur is compromised by a fracture of either high or low energy, it can pose a significant surgical challenge to treat.

Not only are most of these fractures intraarticular in nature occurring close to the joint but also often they are complicated , resulting in many fragments of bone that serve absolutely no structural support to the femoral construct.

MECHANISM OF INJURY

In this section we will see how the lower end of the femur is fractured. When there is axial loading with varus, valgus and rotational forces the fracture occurs but a direct force can also produce fractures in this region.5-10 % of distal femur fractures are open especially at the anterior thigh proximal to the patella possibly due to less musculature.

Fig : 6 Pull of gastrocnemius

In younger patients, the injury typically occurs after high energy trauma related to vehicular accidents. In such patients not only is there is considerable displacement and comminution but also they have associated injuries. In contrast in the elderly, these fractures occur even after a trivial fall on the flexed knee causing associated comminution. This is mainly due to age related osteoporosis. The deformities that arise from supracondylar femoral fractures are produced primarily by the direction of the initial fracture displacement and secondarily by the pull of the strong musculature. The typical varus deformity is due to the strong pull of the adductors.[26]

The posterior angulation of the distal fragment is due to contraction of the two heads of the gastrocnemius (Fig 6). The pull of the hamstrings and quadriceps [26] cause limb shortening and angulation at the fracture. In fractures with intercondylar extension, muscle attachments to the respective femoral condyles tend to produce splaying and rotational malalignment contributing to joint incongruity.

CLASSIFICATION OF DISTAL FEMUR FRACTURES

As there are many classification but certain factors, which play a dynamic role in management, determine the “personality” of a fracture. Among these are:

(1) amount of fracture comminution and displacement

(2) extent of soft-tissue injury and associated neurovascular injuries

(3) magnitude of joint involvement

(4) depends on bone quality

(5) presence of multiple trauma and complex ipsilateral injuries for example when there is associated patella or plateau fractures).

Classification systems in use

1. Neer’s Classification,
2. Stewart’s Classification
3. Schatzker Classification
4. Seinsheimer Classification
5. AO Classification

DESCRIPTIVE CLASSIFICATION[27]

This is another version of classifying distal femur fractures.

- Open Vs Closed
- Location-Supracondylar/ Intercondylar
- Pattern-Spiral , Oblique Or Transverse
- Angulation – Varusor Valgus or Rotational
- Displacement- Shortening or Translation
- Comminution, Segmental /Butterfly fragment

In our study we are using the AO classification system because it is easy to use and applicable to most parts of the skeleton and basic treatment plan for distal femur fractures usually can be formulated based on this classification system.

However, some fractures do not fit neatly into any classification scheme. This emphasizes the fact that every patient must be individually evaluated, and the "personality" of the fracture must be considered in selecting the method of treatment.

Neers classification

Type 1 Non displaced fractures with less than 2 mm of displacement

Type 2-Fractures involving the distal metaphysis only, without intraarticular extension

A-Two part

B- Comminuted

Type 3- Fractures involving the intercondylar notch in which one or both condyles are separate fragments

A- Medial separate

B- Lateral separate

C- Both condyles separate from the shaft and from each other

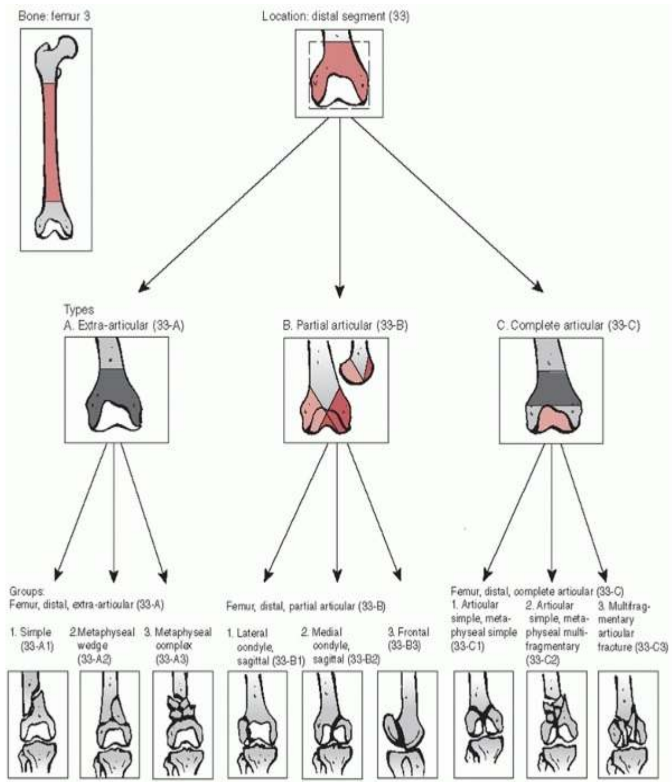
Type4-Fractures extending through the articular surface of a femoral condyle

A-Through the medial condyle (two part or comminuted)

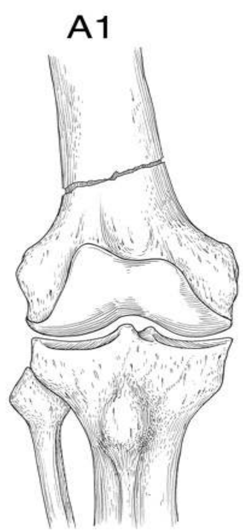
B- Through the lateral condyle (two part or comminuted)

D- Complex and comminuted

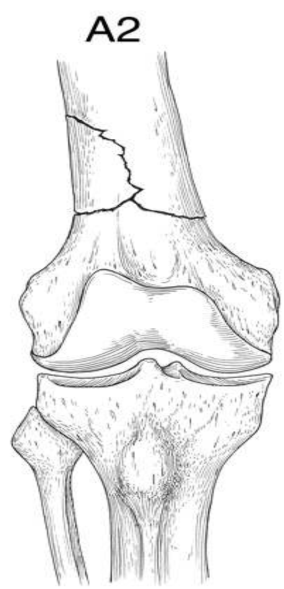
Muller Classification



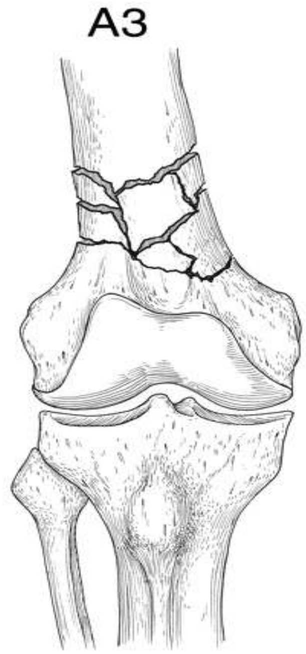
A –Extra-Articular



A1-Simple

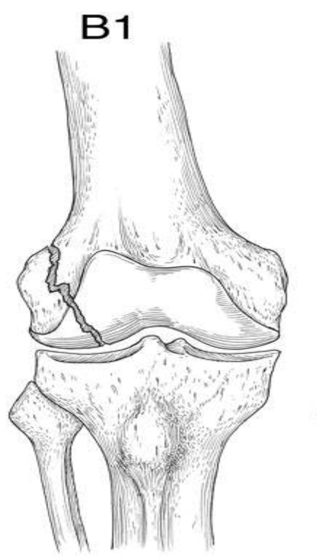


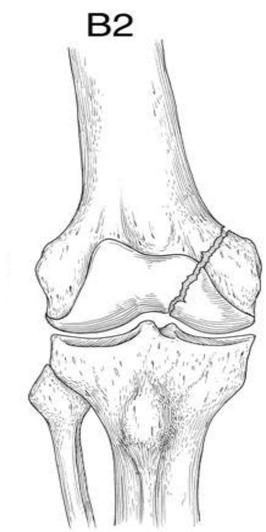
A2-Metaphyseal wedge



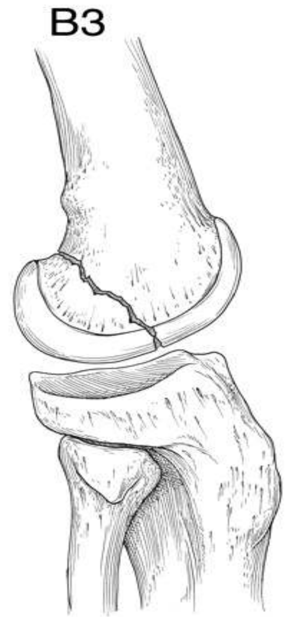
A3-Metaphyseal complex

B-Extra articular condylar



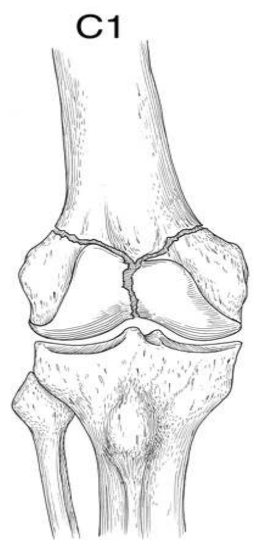


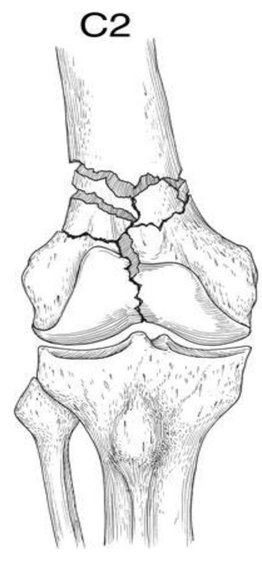
B1-Lateral condyle fracture sagittal B2-Medial condyle fracture -sagittal



B3-Fracture in coronal plane (Hoffa fracture)

C- Intra articular

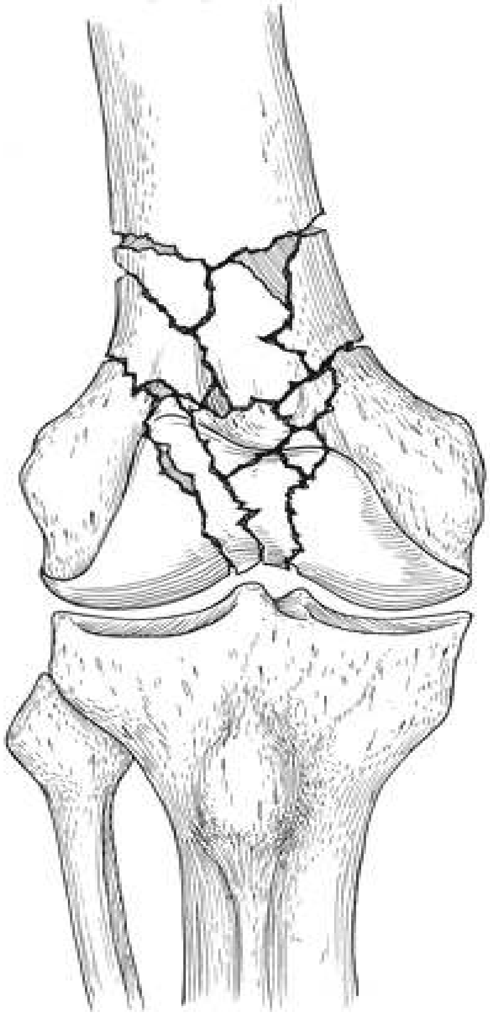




C1-Articular simple metaphyseal T or Y shaped fracture

C2-Articular simple, metaphyseal multifragmentary

C3



C3-Articular and metaphyseal multifragmentary

IMPLANTS USED IN MANAGEMENT OF DISTAL FEMUR FRACTURE

1.95º CONDYLAR BLADE PLATE (CBP)

Fig 8.1: A 95º angled blade plate

It is one of the first implants used in supracondylar fracture. When used by an experienced surgeon, it restores alignment and provides stable internal fixation. Because it is a single piece device, it provides the best possible control of the fracture. However placing of the CBP is a technically demanding procedure, leaving little room for error. It can be used for intercondylar fractures provided the lateral cortex is not comminuted.

The main advantage of the Condylar Blade Plate is the increased strength and increased corrosive resistance of the implant. The disadvantage is the increased difficulty of insertion. Initially the 130 degree plate was used for the distal femur also. With time it became evident that the 95 degree plate was the more physiological implant. The plate is available in various lengths of the blade plate, the shortest available being 50 mm.

2. DYNAMIC CONDYLAR SCREW (DCS)

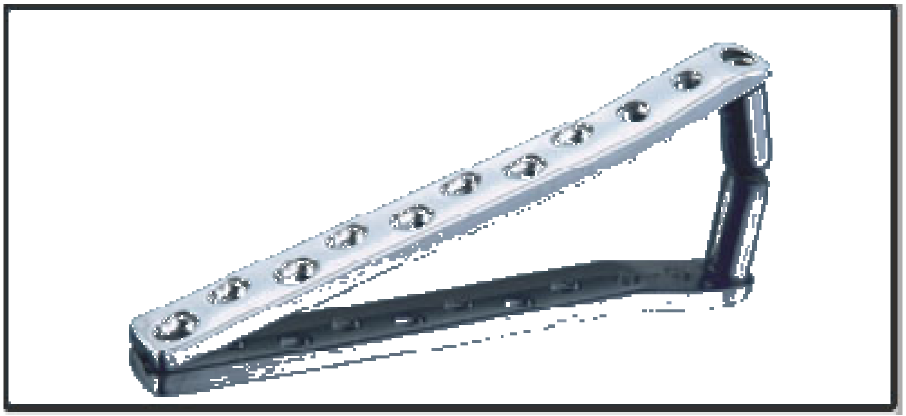


Fig 8.2: A DCS barrel plate

DCS is a modular system which works with a lag screw principle. It has a large diameter terminal threaded screw called the DCS screw and the angle between the plate and the barrel in the DCS barrel plate is 95º. The barrel will slide over the unthreaded portion of the DCS screw. The plate has a round and oval hole in the DCS barrel plate. The Dynamic Condylar Screw is inserted above and parallel to the patello-femoral joint [28]in the axial view. The threaded portion should cross the fracture site. This causes compression at the fracture when the screw is tightened. The large diameter threads of DCS lag screw firmly grip the cancellous bone. The holes of the DCS side plate when used in compression mode causes compression at the extra articular portion (shaft and metaphysis) of the fracture site.

The following are the errors and pitfalls possible with this implant .A condylar screw inserted in a valgus position will force the knee into varus when the side plate is attached to the shaft, conversely when inserted in varus, a valgus position of the knee will result. Any screw inserted far too dorsally will cause anterior and medial displacement of the distal fragment. Advantages of DCS are

a) The easier and more familiar technique of insertion
.
b) Interfragmentary compression can be obtained with a lag screw.
c) Fracture flexion and extension can be adjusted after the lag screw insertion unlike blade plate in which it is not possible.
d) It can be inserted by a small incision.

Disadvantages are

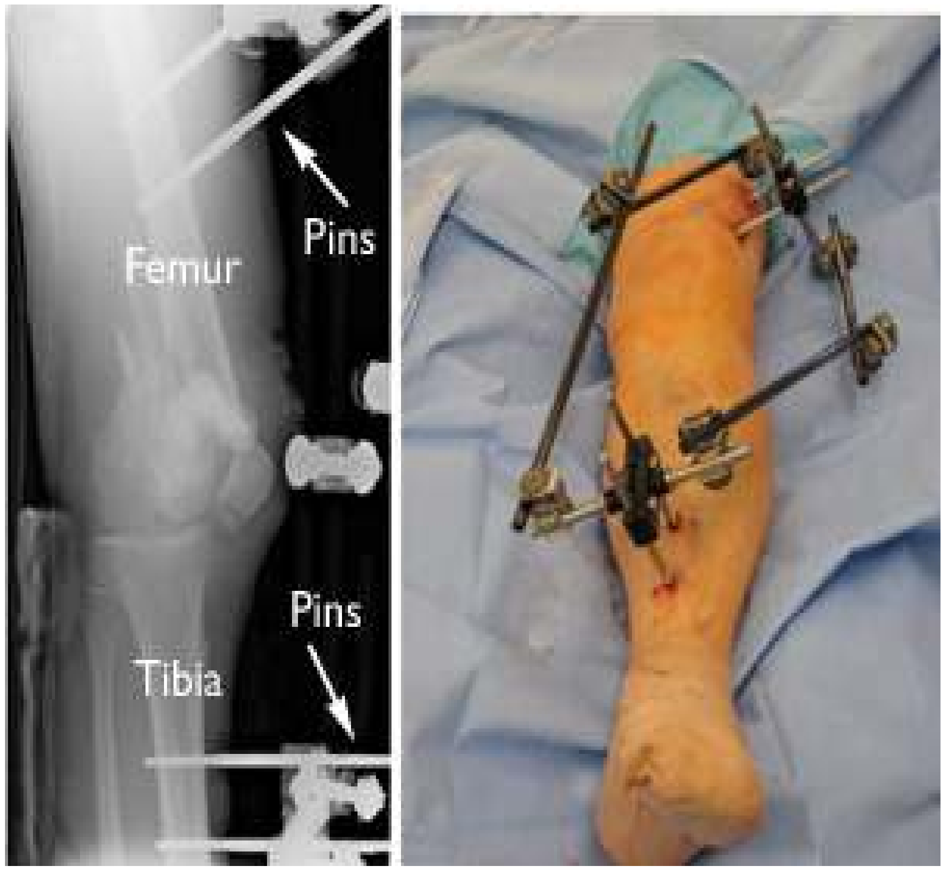
a) The increased bulk of the device.
b) The amount of bone removed so as to accommodate the screw and barrel is more than for a blade plate
c) The difficulty to apply this in extremely distal fractures (at least 4 cm of intact lateral cortex above the intercondylar notch of femur is needed to apply it).

3. DISTAL FEMUR NAIL

GSH Nail with interlocking screws

This Nails have been developed specifically for retrograde insertion through the intercondylar notch. It was developed by Green, Seligson and Henry and hence was called GSH nail. It is a cannulated closed section stainless steel intramedullary device designed specifically to provide fixation for supracondylar fracture. It has an 8 degree apex anterior bend near the distal end to accommodate the geometry of the femoral condyles and transverse holes along its entire length to allow interlocking with 5 mm screws. It is available in various lengths and diameter. The most unique feature of this nail is its intra-articular starting point, allowing it to be used for very distal fractures. Closed placement with indirect reduction of the fracture minimizes soft tissue and periosteal damage, thus preserving vascularity of the fracture site. Less surgical dissection is required resulting in less blood loss, less muscle damage and less postoperative discomfort. It can also be used in cases of floating knee, for simultaneously fixing femoral or tibial fractures. The design of the retrograde supracondylar nail is associated with potential disadvantages as well, the intra-articular portion may lead to knee stiffness, patello-femoral degeneration and synovial metallosis. The proximal tip of the nail generally lies in the mid or distal femoral shaft creating a stress riser in this area.

4.EXTERNAL FIXATION



Distal femoral fracture stabilised by an AO extenal fixator

It may be used alone or in combination with limited internal fixation as follows. Grade 1, 2, 3a injuries can be managed with internal fixation after irrigation and debridement. Grade 3b and 3c injuries have to be managed by debridement and irrigation followed by external fixation and delayed internal fixation, problems include pin tract infection, quadriceps scarring , delayed union or non union and loss of reduction after device removal. An Ilizarov frame can also be used in the management of these fractures.

5.FLEXIBLE AND SEMIRIGID NAILS

Zickel intramedullary nail

In 1970, Zickel developed a nail designed specifically for use in the distal femur, the nail has a flexible stem and a rigid curved condylar part, allowing it to be anchored by trans fixation screws into femoral condyles. Closed Rush pinning[5] was also used for the management of supracondylar fractures but it was associated with complications like pin migration, knee irritation , loss of reduction and malunion.

6.CONDYLAR BUTTRESS PLATE

Condylar Buttress Plates (Right and Left)

Blade plate and condylar screws are unsuitable for use in fractures with < 4 cm of intact femoral condylar bone and in presence of articular comminution. For these fractures, the Condylar buttress plate is the most preferred implant[29]. It is a one piece device designed for the contour of the lateral surface of the right and left distal femur. It is essentially a broad DCP with a cloverleaf shaped distal portion designed to accomodate upto 6 cancellous screws. Mechanically it is not as strong as a blade plate or condylar screw with side plate and therefore should not be substituted for these implants. The problem with condylar buttress plate is that the screws do not pass in any fixed angle in relation to the distal holes as is seen in a locking plate. With indirect reduction techniques the screws may shift relative to the plate producing varus deformity or valgus deformity, so its use should be restricted to cases in which the lateral femoral condyle is comminuted or there are multiple intraarticular fractures in the coronal or sagittal plane. In cases with extensive medial comminution a second medial plate needs to be used to prevent varus deformity.

Distal femoral Locking Compression Plate

After undergoing wide literature review about history and other fixation devices now we will focus about locking plate and as we all know that conventional plates has successfully stabilised not only fractures but alsoosteotomy sites for decades and the plate and screw construct should not only withstand physiological loads but also allow fracture union and at same time permit early limb motion, without fixation failure but in conventional plating like solving the jigsaw puzzle the fragments of bone were reduced withoutgiving any respect to the soft tissue attachments which led to complication like delayed union,non union, implant failure, etc. so to achieve above mentioned goal, periosteal stripping andsoft tissue dissection should be minimal to promote bone union.

So with this idea the biological plating techniques were introduced for treating such fractures and first attempts were done by Boitzy and Weber but it has gained popularity in the 1980's. In 1989 mast et al when mentioned about the indirect reduction technique and subsequent development of wave plate , bridging plate brought about a basic change to fracture treatment using plates.

Principles of Biological fixation are

1. Repositioning and realigning by manipulation at a distance to fracture site, preserving soft tissues (Indirect reduction techniques).
2. Leaving comminuted fragments out of the mechanical construct, while preserving their blood supply
3. Using low elastic modulus, biocompatible materials.
4. Limited operative exposure.

One such method isMinimally invasive plate osteosynthesis (MIPO) in which plate is inserted percutaneouslyand it is fixed at a distance proximal and distal to the fracture site through minimal exposure.

So the Advantages of MIPO are :

1.Simpler technique and easy to master with short learning curve

2.No need of additional expensive instrumentation.

3.Improved rates of fracture union.and decreased infection rate and need for bone grafting.

4.Early mobilization

5.Decreased incidence of refracture after plate removal

WHAT IS LOCKING PLATE

Any plate that allows the insertion of fixed-angle/angular-stable screws or pegs can be used as a locking plate.

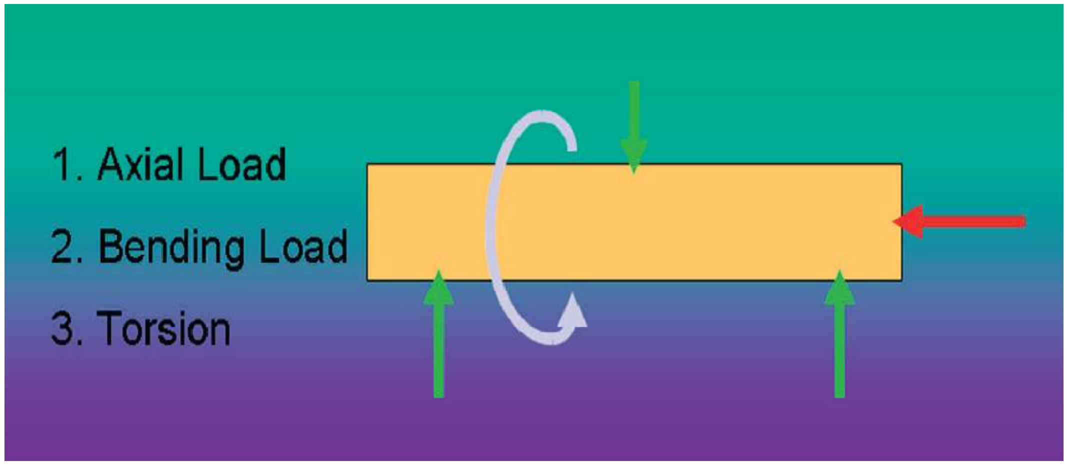
Theconventional plates require two important factors for fixation

1.compression of the plate to the bone

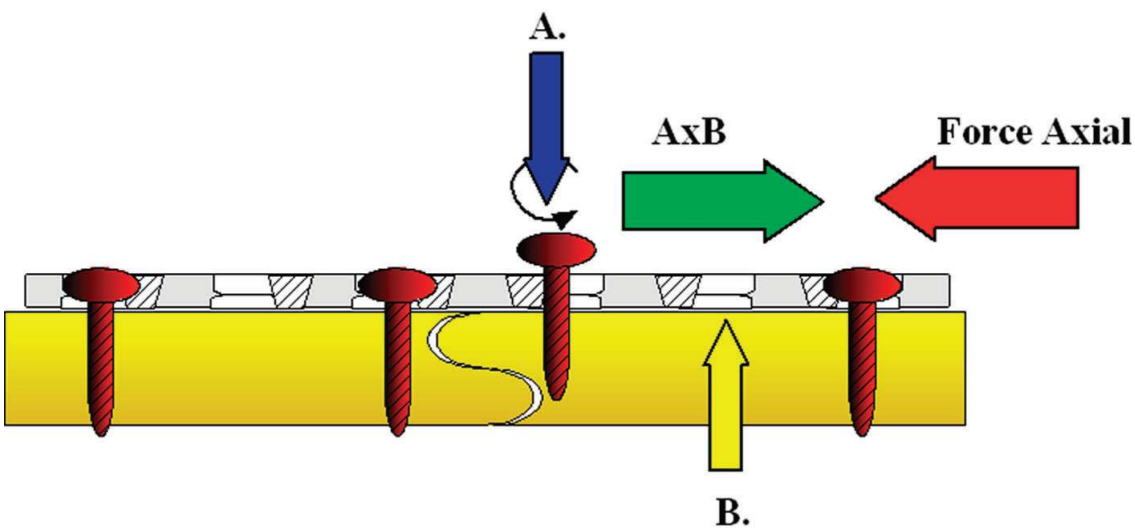
2.friction at the bone-plate interface

but the locking plate do not need it because of this when axial loading cycles is increased first the screws loosens then due to reduction of frictionforce, plate also loosenand if this occurs prematurely we all know that implant failure occur. Sothe plate osteosynthesis construct should not only withstand physiological loads but also allow fracture union and at same time permit early limb motion, without fixation failure and blood supply to fragments should be given respect so that we can get optimal result.

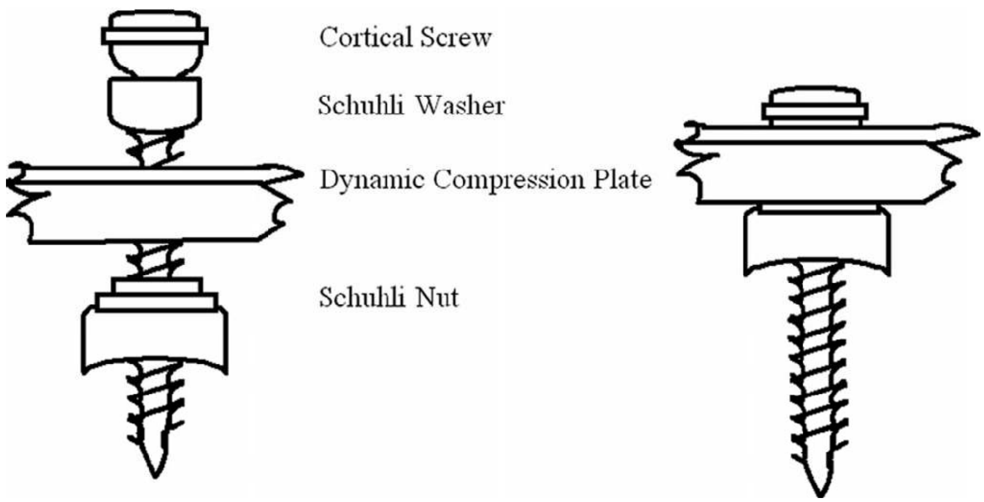
To achieve this goal, soft tissue dissection and periosteal stripping should be minimal to promote bone union [78,79]. Ideally maitainence ofjoint congruity to within <2 mm. and mechanical limb alignment should be restored. Finally for a successful fixationfollowing three forces must be neutralised as shown in below figure

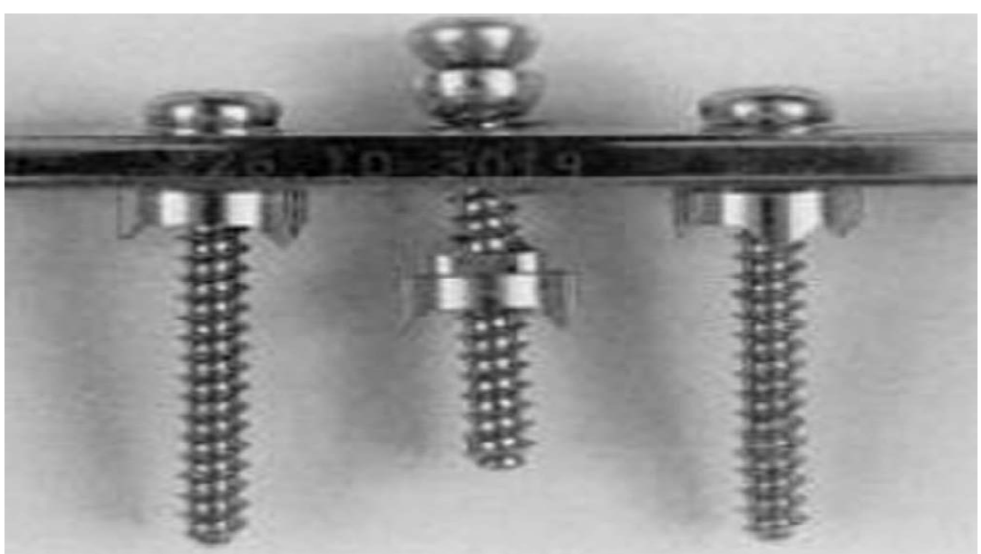


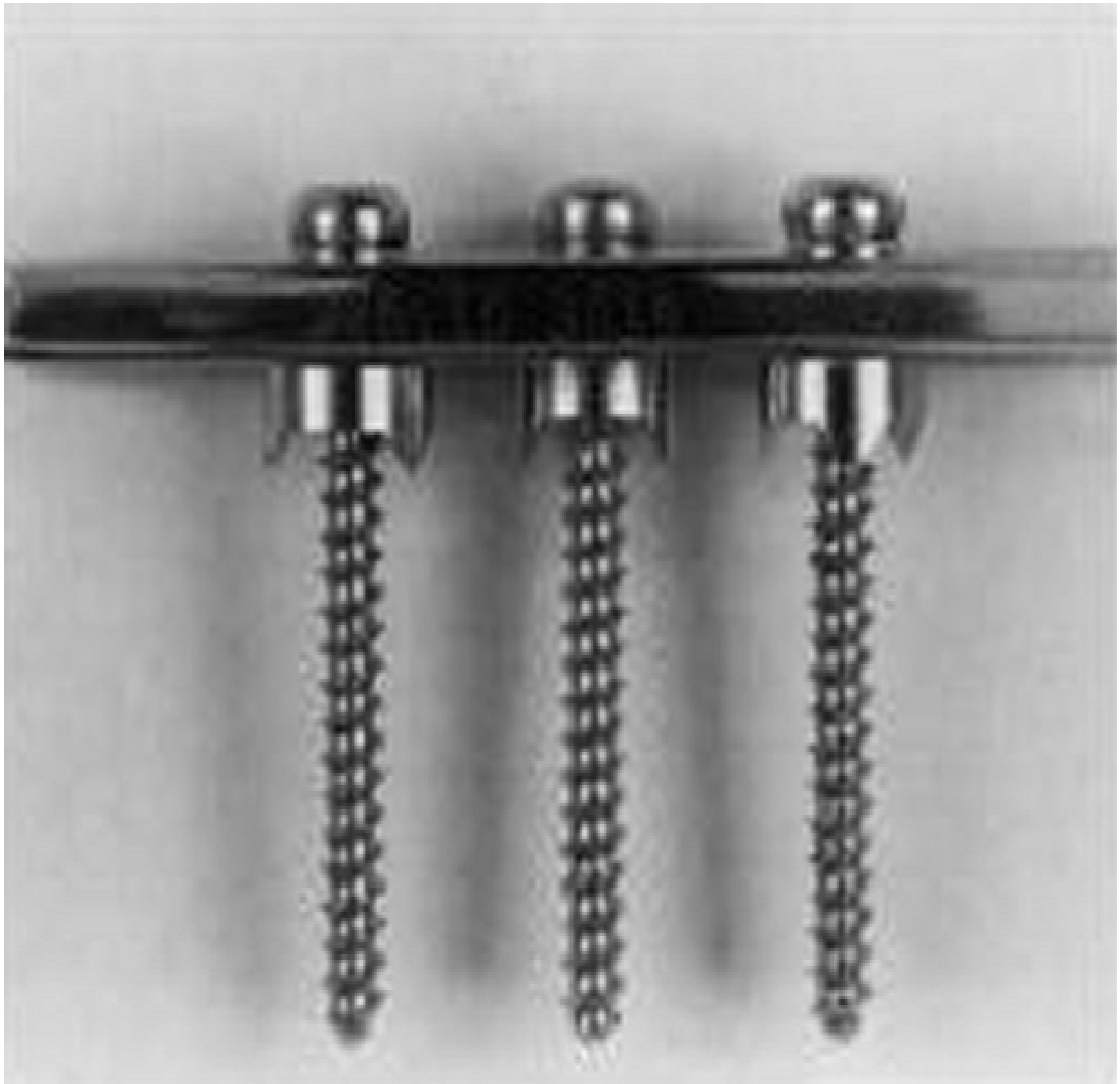
When conventional plates is used then it is observed that the force friction between the plate and the bone counters the external forces experienced by the fixation construct as shown in below figure 8.



Therefore, to achieve stability for the conventional plate osteosynthesis, screw torque becomes the limiting factor and there are certain conditions when sufficient torque (1.5 N) is not developedegOsteoporotic bone , cancellous bone,pathological bone and when comminution, [75,76]is there so to improve the friction coefficient between the plate and the bone stripping of periosteum andsoft tissue dissectioncan devitalise the bone fragments and softtissue flaps and not only that by limiting exposure we can good cosmetic results. So to improve fixation in case ofcompromised bone lot of research work were going on for example they included the use of cement to improve screw torque [10]. Schuhli nuts[77] were developed initially which can act asfixed angle construct which is shown in below figure

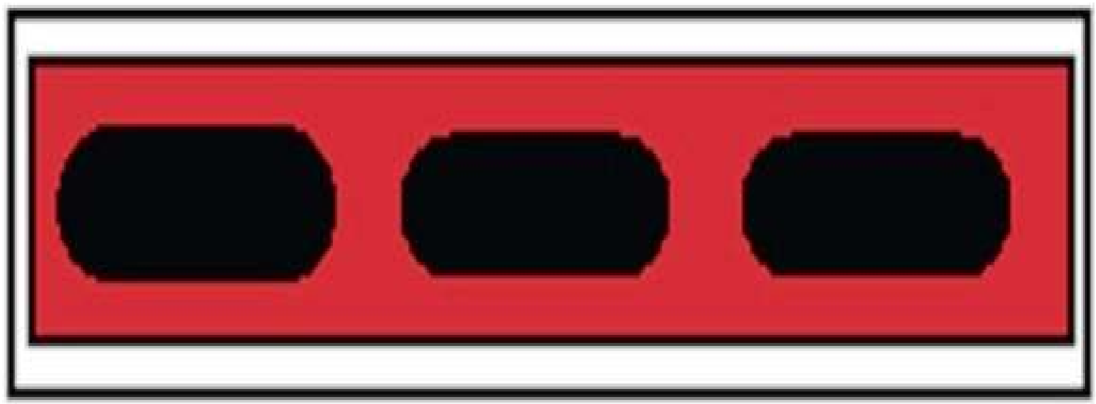






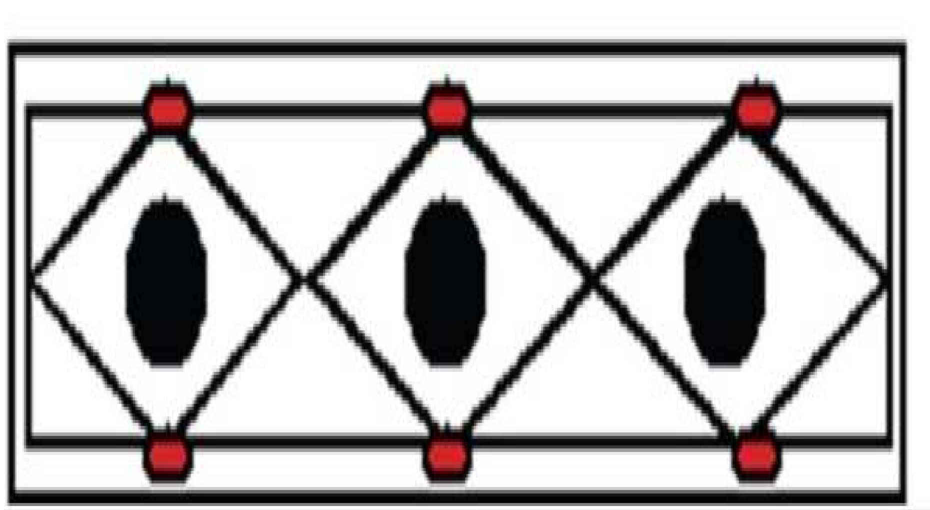
And to preserve the blood supply to the bone by reducing plate bone contact which is shown in figure below. (The contact surface is shown red).

DCP



LC-DCP

POINT CONTACT FIXATOR

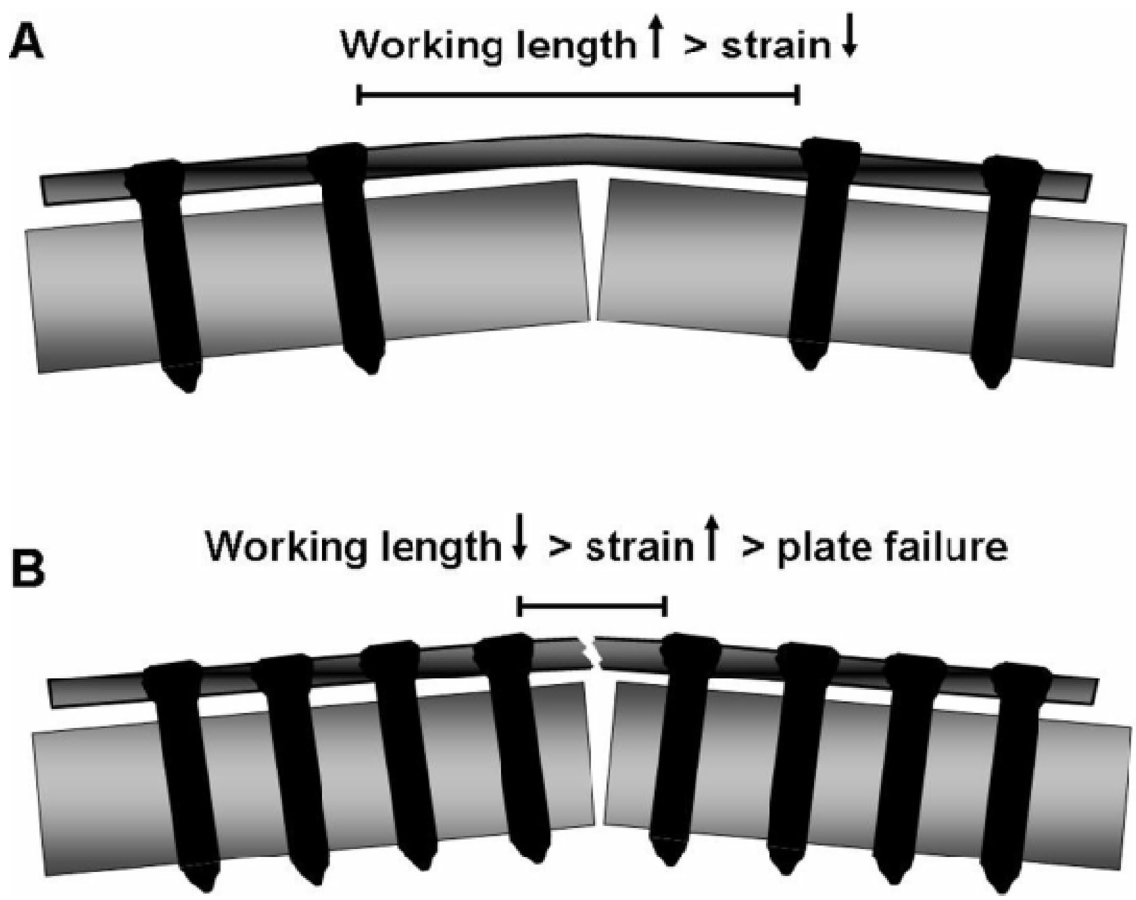


The below shown figure how lcp preserves the periosteal bloody supply

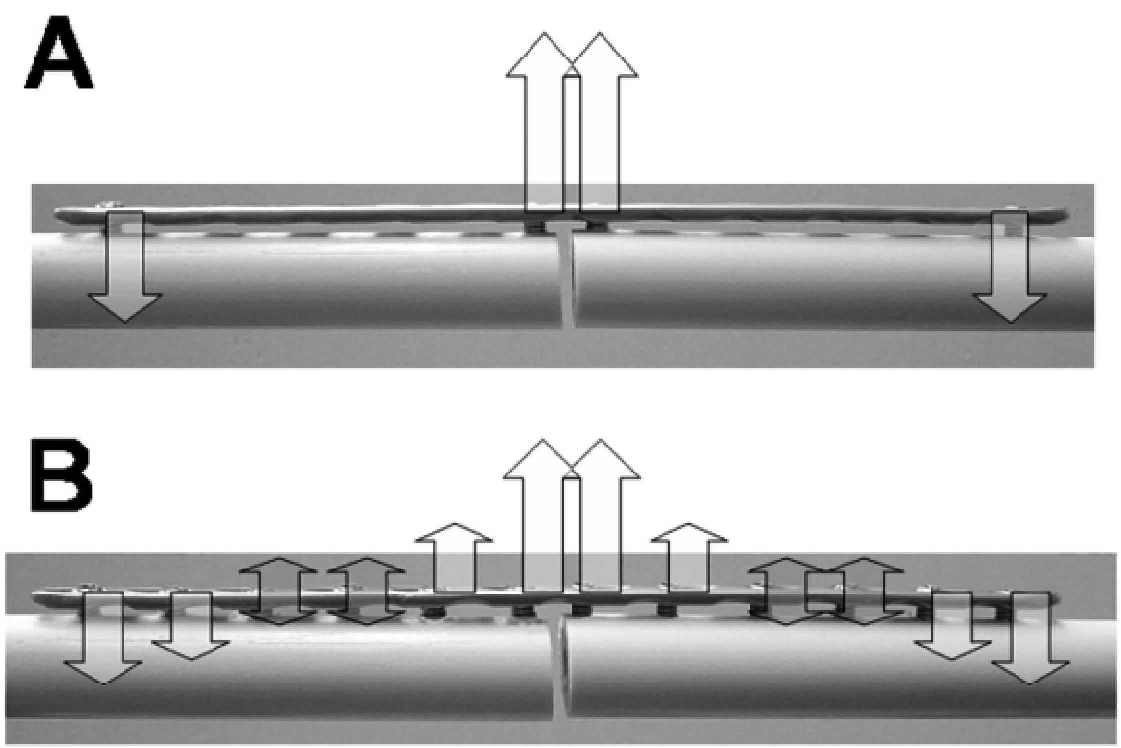
Advantage of preserving the blood supply to bone

1. Prevention of infection in a sequestrum under the deep surface of the plate
2. Minimize or avoid refracture after hardware removal.
3. Prevention of non-union and delayed union

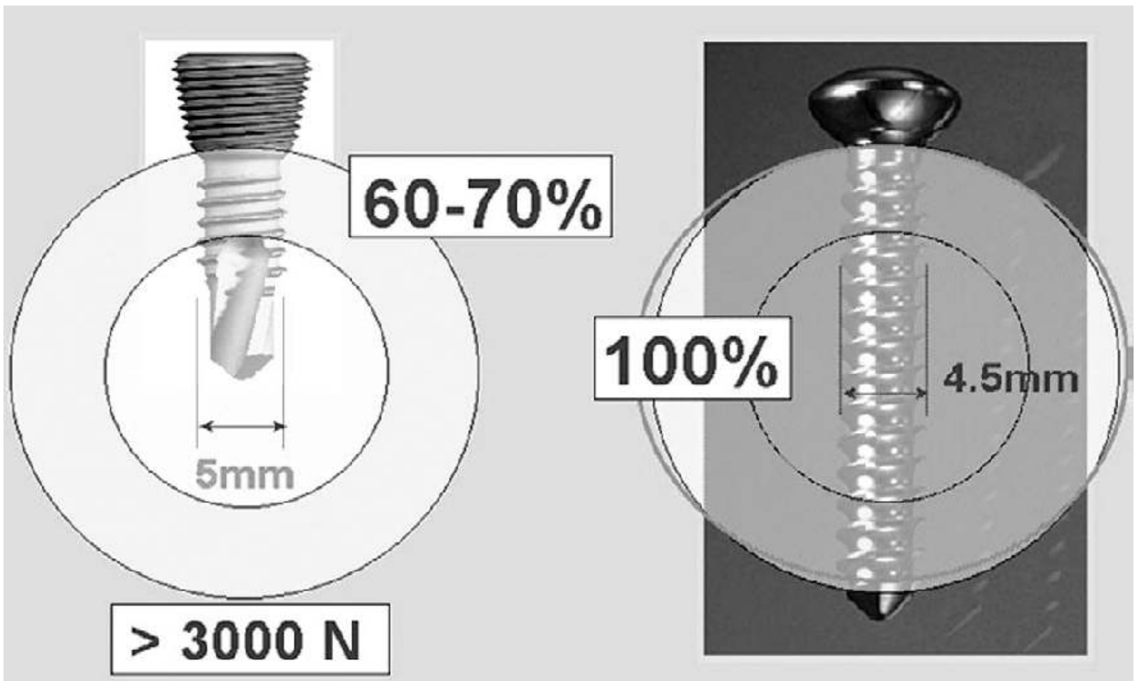
The Locked plates should be considered as extremely rigid internal external fixator so they run the risk of becoming “nonunion generators.” However, we can dynamize the external fixators, but LCP are very difficult to dynamize.



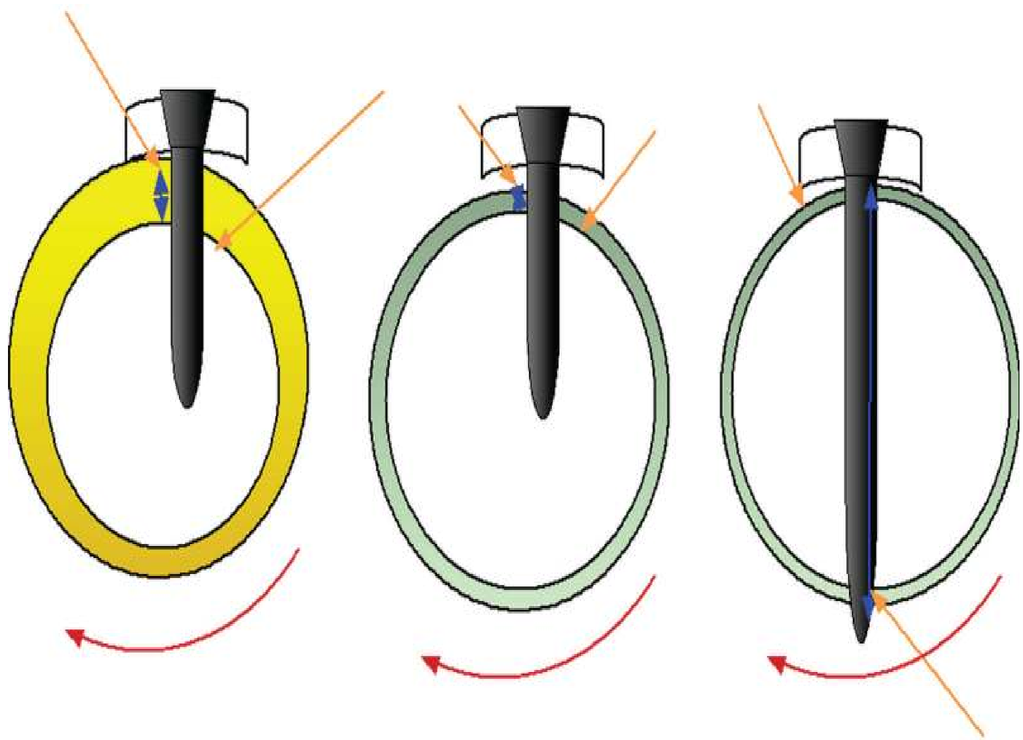
The above shown figure shows relationship of working length and strain at the level of the fracture .we can notice that to increase the working length three or four plate holes should be left empty at the level of the fracture and so that strain and stress concentration on the plate is decreased as shown in first top figure. but when working length is short there is increased stress and srain concentration with loading and torsional forces, which results in implant failure By placing too many screws as shown in figure B so when the working length is increased it decreases stress in the screws when there is a 1-mm fracture gap whereas when the fracture gap is >1 mm it has no effect and in this situation the bone cannot share the load the plate is in a bridging mode . When the plate-bone distance is increased it decreases axial and torsional stiffness, whereas if length of the plate is increased it increases only axial stiffness but there is no effect on torsional stiffness, whereas if length of the plate is increased it increases only axial stiffness but there is no effect on torsional stiffness.And below figure shows theanalysis of forces in dependence of the screw number and itshows different distribution of bending forces with minimal number of screws (A) and maximal number of screws (B)



Biomechanical studies reveals that monocortical locking head screw (LHS) has 70% holding force where as there is 100% in case of conventional bicortical 4.5 mm screw which is shown in figure below

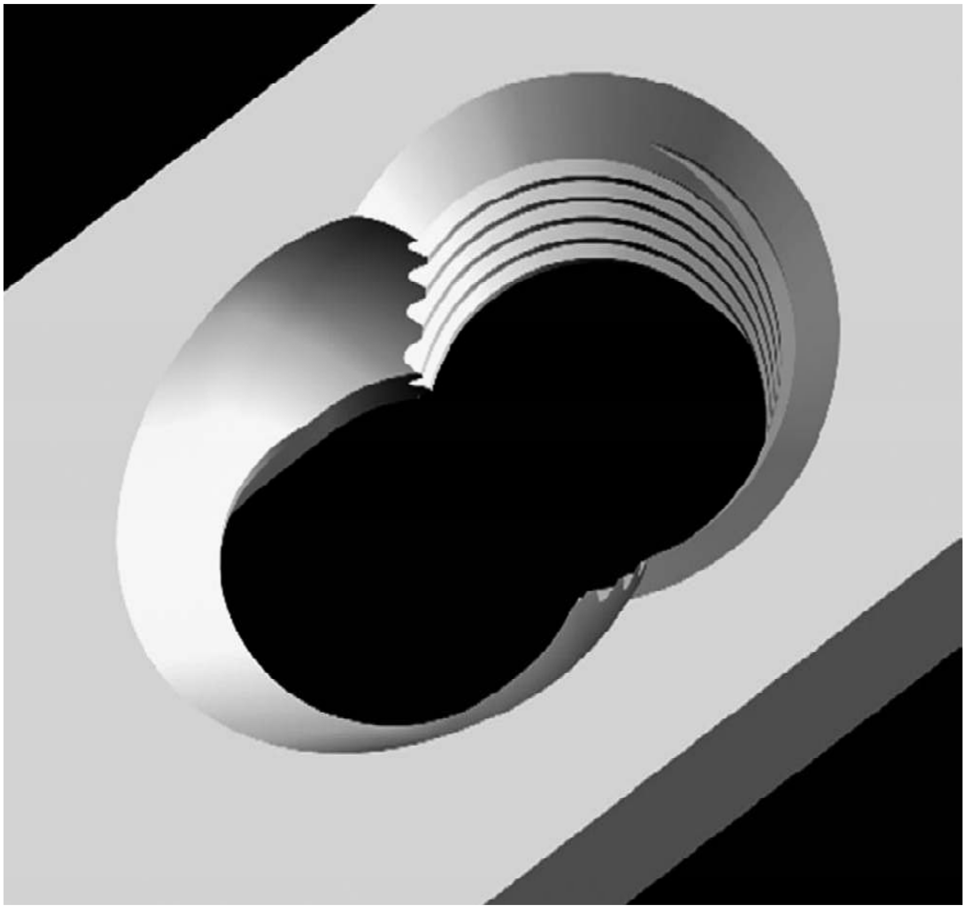


Fixed-angle screws effectively act together in paralleland convert forces of axial loading and three-point bending to compression , whereas conventional screws act in series and fail by toggling within the bone[24]. One of drawback of Unicortical screws is in their inability to resist torsional loads because intorsional loadworking length is important and cortical thickness becomescritical for a unicortical screw to resist torsional loads. below figure shows the difference in the working length (blue arrowheads) of unicorticalscrews in osteoporotic (green) bone normal (yellow) bone compared withnormal (yellow) bone. In normal bone, the working length may be sufficient to resist applied torque (red arrows) but in osteoporotic bone, bicortical screws provide a much greater screw working length and improved resistance to torsional stress at the screw-bone interface(orange arrows).



So we can see the advantages of bicortical fixationwith regard to screw working length far outweigh the advantagesconferred by healthy cortical bone.

So for these reasons bicortical locked screw should be employedwhenever high torsional loads are expected .



So depending on the fracture site the presence of Combination hole in LCP gives surgeons the opportunity to combine principles of dynamic compression and internal fixation. andwhen used as “bridge plates” itpreserve blood supply to bone fragments and provide fixed angularstability with the added advantage of reduction of risk of primary loss of reduction as exact plate-contouring is not required and improved fixation in osteoporoticbone

INDICATIONS FOR LOCKING PLATE (Gautier and Sommer et al [74])

Indication	Compression	Bridging	Combination
Diaphyseal fractures	Yes	Yes (3-4screw holes empty over fracture)	
Metaphyseal fractures	Yes	Yes (3-4screw holes emptyover fracture)	
Multifragmentary diaphyseal fractures		Yes (near far/far near)	
Multifragmentary metaphyseal fractures		Yes (near far/far near)	
Articular fractures	Anatomical reduction		
Segmental with two different fracture patterns			Compression/bridging
Articular fractures with multifragmentary Metaphyseal or diaphyseal fractures			Compression articular fragments/bridging

CONTRAINDICATION

So when indication are there so are the contraindication and they are listed below

Contraindication	Technique used	Example	Outcome
Simple fractures	Locked internal fixator	Simple forearm or humeral shaft Fracture	Non-union
Simple fractures	Mippo	Simpledistaltibial fracture	Non-union

If standard principles for useof locking plates are not followedeventhe locking plate fails in certain conditionsin which there iscontraindication for LCP use For example if simple diaphyseal fractures of theforearm are fixed with a LCP then they areprone tonon-union . Similarly if percutaneous locking platefixation of simple fractures using MIPPO technique is used then as described by Stephan Perren[80] it violates the principle of the fracture gap width in relation to strainand thus leads to non-union.

Locking plates are relatively contraindicated for fractures that can be stabilized satisfactorily with conventional plates because of cost factorFor example, when diaphyseal forearm fractures have healing rates in excess of 90% using conventional plates so it is ridiculous to use locking plate and in certain clinical situations whenlocked plates are unnecessary eg when good quality diaphyseal bone is present in which compression of fracture is enough and for the fixation of pelvic and acetabular fractures.

Now the locked plates have creeped into the minds of surgeons so the numbers of fractures fixed with LCP have increased and if principles of fixations are not followed the locking plate can also fail which should be kept in mind.

PRINCIPLE OF THE LOCKING COMPRESSION PLATE

When locking plate is applied there are someimportant considerations to be borne in mind .and the main principles are :

(1) the compression principle, for osteoporotic diaphyseal fractures.

(2) the neutralization principle, also for osteoporotic diaphyseal fractures

(3) the bridging principle ("locked internal fixator" principle), for comminuted diaphyseal or metaphyseal extra-articular fractures

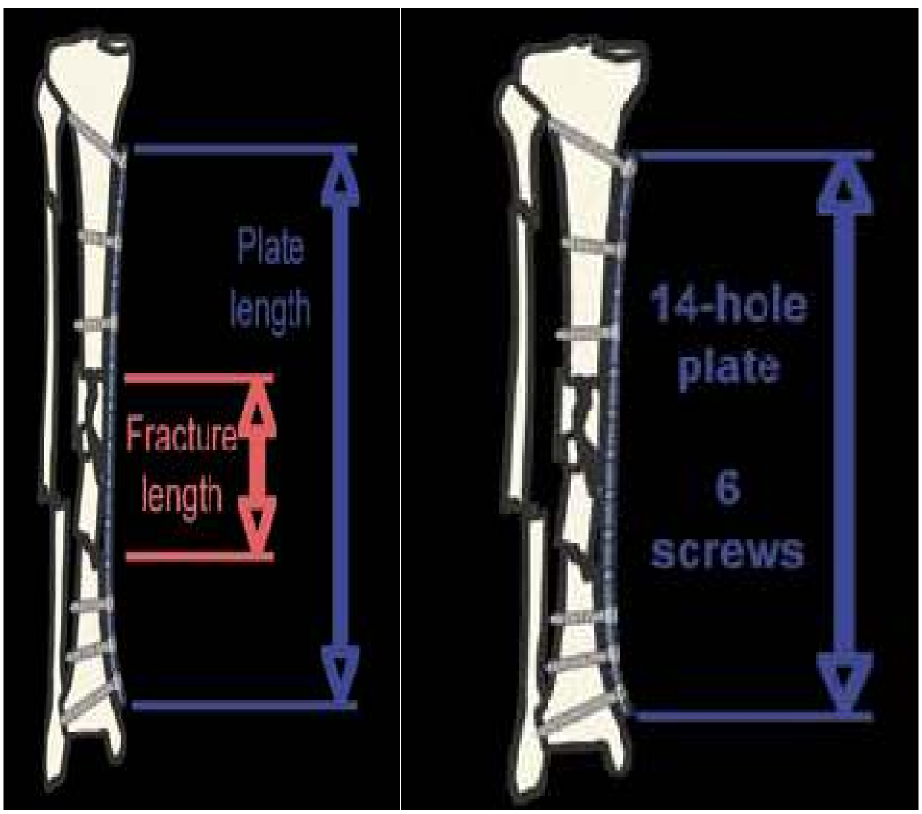
(4) thecombination principle ("combiplate"principle), for comminuted metaphyseal intra-articular fractures

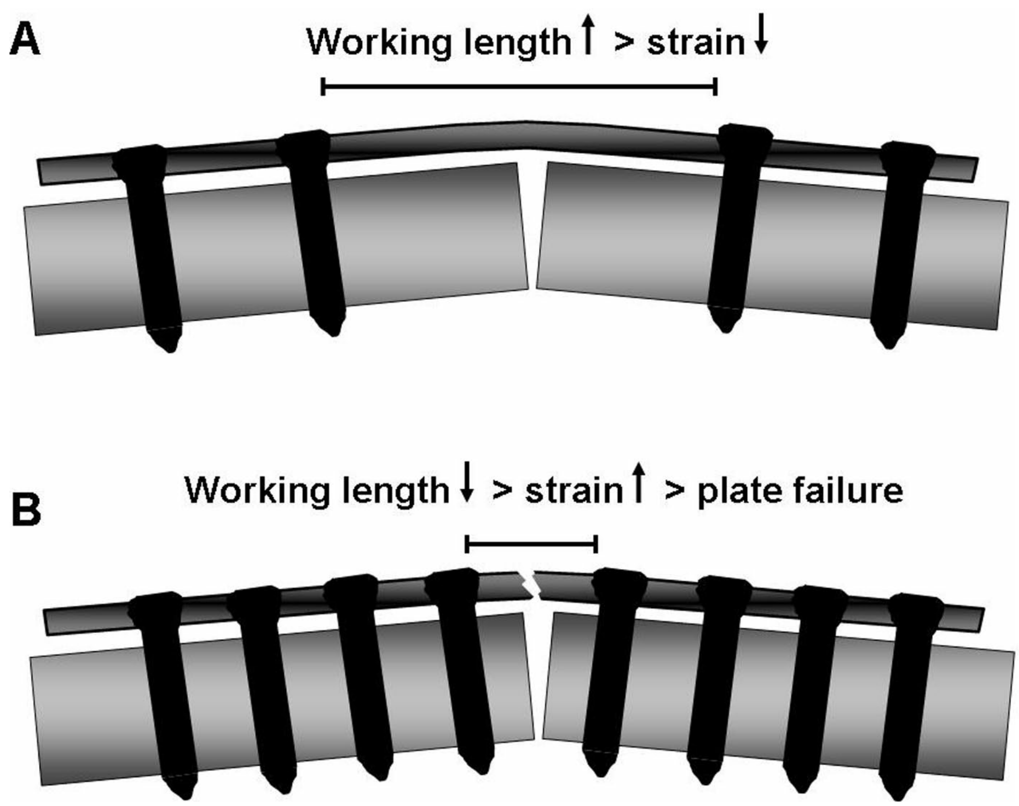
1. **Length of the plate**: the ideal plate length can be determined by the plate span width and plate screw density.

$$\text{plate span width} = \frac{\text{plate length}}{\text{overall fracture length.}}$$

This should generally be more than 2-3 for comminuted fractures and higher than 8-10 in the case of simple fractures.[74]

The second factor is theplate screw density and the value should be below 0.5, indicating that less than half of the plate holes are occupied by screws which is discussed in next point.





The above shown figure shows relationship of working length and strain at the level of the fracture .we can notice that to increase the working length three or four plate holes should be left empty at the level of the fracture and so that strain and stress concentration on the plate is decreased as shown in first top figure. but when working length is short there is increased stress and srain concentration with loading and torsional forces, which results in implant failure By placing too many screws as shown in figure B so when the working length is increased it decreases stress in the screws when there is a 1-mm fracture gap whereas when the fracture gap is >1 mm it has no effect and in this situation the bone cannot share the load the plate is in a bridging mode . When the plate-bone distance is increased it decreases axial and torsional stiffness, whereas if length of the plate is increased it increases only axial stiffness but there is no effect on torsional stiffness .

2. **Number of screws**:

$$\textbf{Screw density} = \frac{\text{No of screws inserted}}{\text{Number of plate holes}}$$

Ideally this value should be under 0.4-0.5

For example, the screw density for a twelve-hole plate with five screws is 0.4 indicating that less than half of the plate holes are occupied by screws.

In contrast to conventional plate osteosynthesis,(a minimum of three, up to six)bicorticalscrews in each fragment should be inserted but when LCP are used it is difficult to recommend a definite number of screws or cortices to be used in each fragment. **but minimum two monocortical screws for each main fragment should be applied so that the construct is stable but for safety reasons it is recommended that two to three screws in each main fragment should be applied , so that stability will be ensured even if insertion of one of the screws is less than optimal.** By using of biocorticalscrews in each fragment does not improve the situationfrom the aspect of screw failure, but it does improve the interface between screw and bone, and it is therefore recommended that at least one of the screws in themain fragment should be a biocortical screw. Biomechanical studies reveals that monocortical locking head screw (LHS) has 70% holding force where as there is 100% in case of conventional bicortical 4.5 mm screwSo we can see that two monocortical screws for each main fragment is sufficient, ideally at least[30].,self drillingscrews should exclusively be used as monocortical screws becausethe stick out length for anchoring in the opposite cortexis too long which increases possible harm to the soft tissues onthe opposite cortex andSelf tapping screws can be used as bicortical screws but in very osteoporotic bones, which typicallypresent a thin cortex or a bone segment under high torsionalloading, the use of bicortical screws is mandatory to enhancethe working length of the screws and to avoid torsional displacement of the fractured fragments

3. **Screw purchase**: Monocortical screws are put so that even if the placement of one screw is suboptimal it would not cause a problem. At least one bicortical screw is placed in each main fragment to improve the interface between the screw and the plate.

4. **Direction of screw placement**: An aiming device in the form of a drill guide or sleeve is preferable while drilling because an axial deviation of drilling by 5 degree can lead to a significant loss of stability and difficulty in fully inserting the screws.

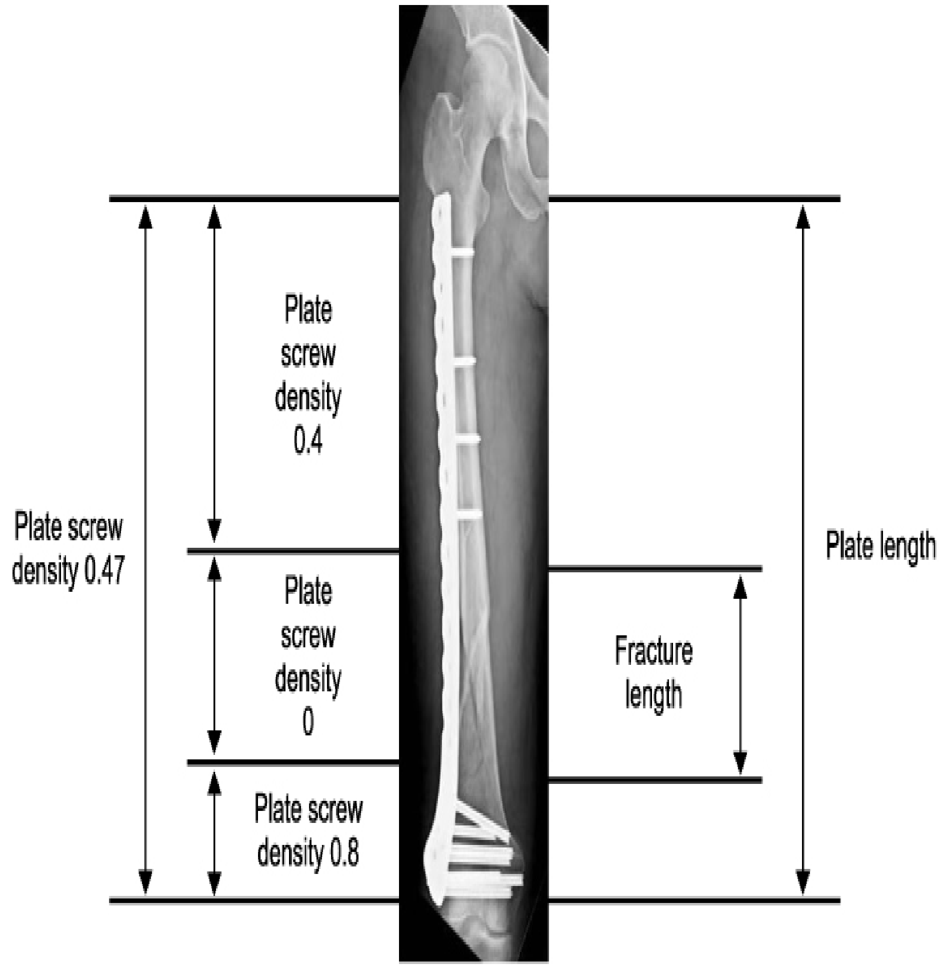


Fig Technical parameters in screw placement

"If the fracture surgeon does something 'LOGICAL' then 'BIO' will do the rest".

anatomist R Schenk

So we can see that length of the plate is important in locking compression plate rather than putting more screws and the plate will not reduce the fracture like conventional compression plate so first reduce than fix this must be kept in mind while fixation and the principles of fixation should never be violated at any cost because locking plate also fail.

AIM OF THE STUDY

Aim of this study is to evaluate the functional outcome of the distal femur locking Compression plates in the treatment of fractures of distal femur.

OBJECTIVES:

1. Whether fractures reduction and fixation with locking compression plate will give acceptable results in the distal femur fractures treated in our setup.

2. To study the clinical outcome associated with this treatment modality

3.what are the potential complication associated with the procedure.

MATERIAL AND METHODS

This is a prospective ,nonrandomised observational study conducted in Department of Orthopaedics,Coimbatore Medical College and hospital patients with distal femur fractures who met our inclusion criteria were selected.

PATIENT SELECTION:

Consecutive patients admitted in department of orthopaedics from May 2013 to september 2014

SELECTION CRITERIA

INCLUSION CRITERIA

1.All distal femur fractures(AO Classification type 33A,C) in sketally mature patients were selected.

2.All patients with open and closed distal femur fractures

3.All patients with polytrauma and with ipsilateral or bilateral distal femur fractures

4.patient who willing to give consent

EXCLUSION CRITERIA

1. Distal femur fracture with AO MULLER CLASSIFICATION TYPE 33 B
2. Patients with tibia plateau fractures
3. Sketally immature patients..
4. Non-union ,malunion distal femur fractures

5. Patient with pathological distal femoral fractures

6. Patients who were terminally ill,with life threatening diseases,who were not fit for surgery.

METHODS:

Implant Used

1.Indian made locking plate and screws manufactured from 316L stainless alloy were used with locking head drill sleeves.

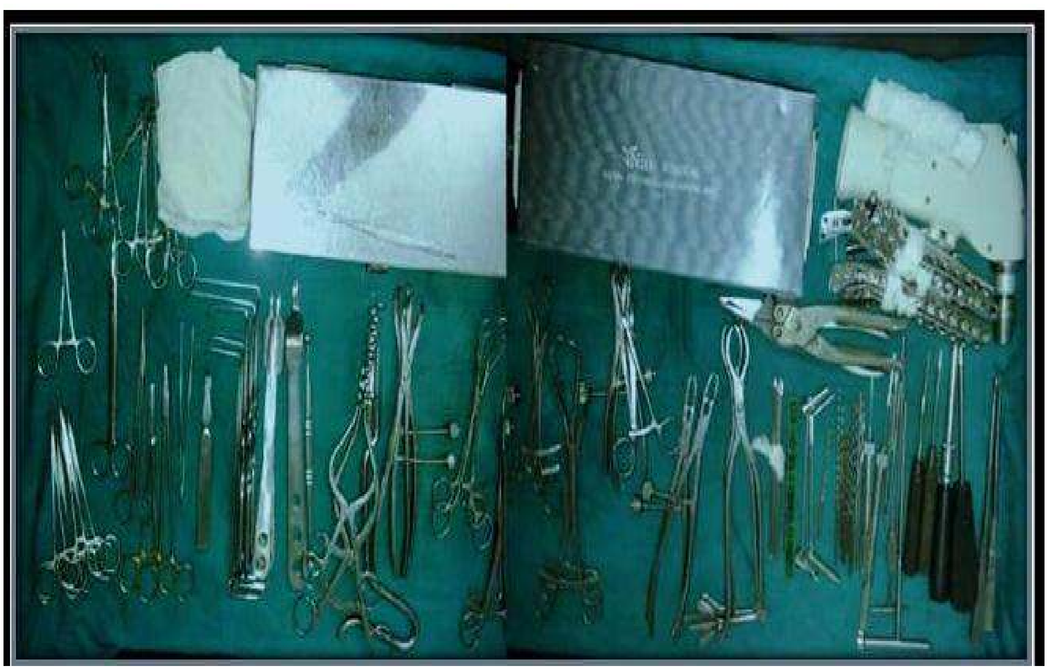
2.The locking compression plates are available from 4 holed to 14 holed. With 4.5 mm thickness plate for lower end of Femur.

3. Anatomically precontoured plate head with soft edges.

4.Locking screws in the head of the plate for a secure support.

5.The head of the locking screw is threaded which gets locked to the plate as it is tightened.LCPcombi-holes in the plate shaft– Intraoperative choice between angular stability and/or compression.

INSTRUMENTATION FOR LCP



ROUTINE PROTOCOL

The study was approved by the Institutional Ethical Committee (IEC) of Coimbatore medical college, Coimbatore. After sorting out the patients on the basis of the already defined inclusion and exclusion criteria, patients were selected for the study and were briefed about

1. The nature of the study
2. The different surgical options available to them and a written informed consent in their own language was obtained.

Further detailed data of the patients involved in the study was obtained by interviewing them and based on clinical examination findings. These data was recorded on a standard predesigned proforma.

PREOP EVALUATION

1. **HISTORY**: The history included details like
   a. Nature of the trauma
   b. Mechanism of injury and the duration since injury
   c. Any significant past history or family history
   d. Any associated injuries

2. CLINICAL EXAMINATION:

Intial survey of trauma : airway. breathing and circulation is carried out then associated pelvic, thoracic, abdominal and spinal injuries were ruled out and secondary clinical assessment with radiological assessment, Local examination of the limb to find out if there was any swelling and deformity, and presence of any open injuries. Vascular status of the limb and any evidence of neurological deficit was carefully looked for and documented.

Once the patient is hemodynamically stable the fractured extremity is immobilised in Thomas splint and later in emergency operation theatre lower tibial or calcaneal pin traction is applied and traction given in Bohlerbraun splint in ward.

3. LAB INVESTIGATIONS

A. Complete blood count

B. Renal function tests and Blood glucose levels

C. Urine analysis

D. HIV and HBsAg status

E. Chest X Ray

F. Electrocardiogram (ECG)

4. RADIOLOGICAL ASSESSMENT

A series of bedside X rays including the AP and lateral projections of the involved thigh and knee and X rays of the pelvis to rule out ipsilateral neck of femur fracture. AP and lateral X rays of the uninjured thigh and knee were also obtained for comparison and templating purposes.

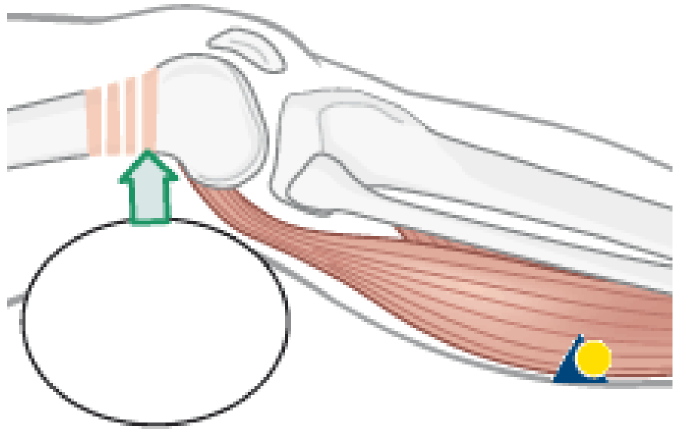
SURGICAL TECHNIQUE

ANAESTHESIA

In the operation theatre spinal anaesthesia was given.

POSITION

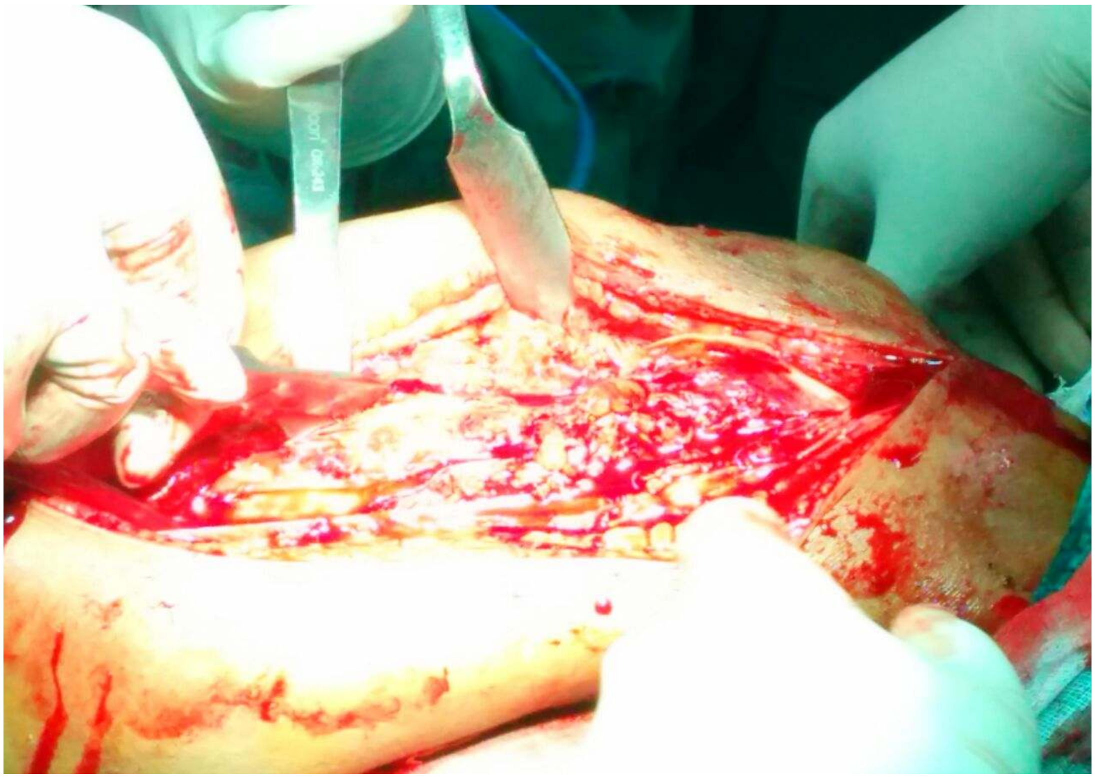
Patient was positioned supine, with a sand bag under the ipsilateral buttock to allow slight internal rotation at the hip. The thigh is draped free and the iliac crest prepared and draped in case bone grafting was required. A sterile sand bag or rolled towel is placed under the knee (Fig 9.1) to facilitate exposure and reduction and to control the flexion of the distal fragment by the pull of the gastrocnemius[26]. Tourniquet was not used because it interfered with the placement and extension of the proximal incision. Broad spectrum antibiotics were given just after spinal anaesthesia and continued postoperatively for 7 days.



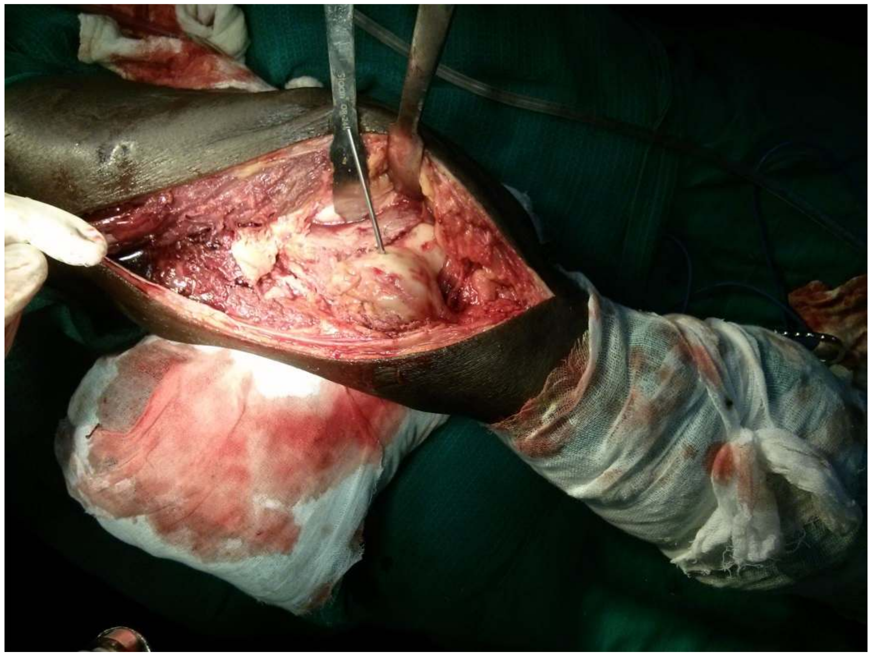
Sandbag under thigh to offset pull of gastrocnemius

INCISION: lateral curved incision extending from just distal to the middle of the thigh to the tibial tuberosity. The knee joint was exposed by a lateral parapatellar approach.

EXPOSURE: The Facia lata is incised in line with the skin incision and the vastus lateralis split in line with the skin incision [24] and retracted anteriorly. Lateral parapatellar arthrotomy is performed to visualise the intra articular comminution of fragments.



REDUCTION: Intraarticular fracture fragments fixed provisionally with K wires or cancellousscrews.then plate fixation is carried on



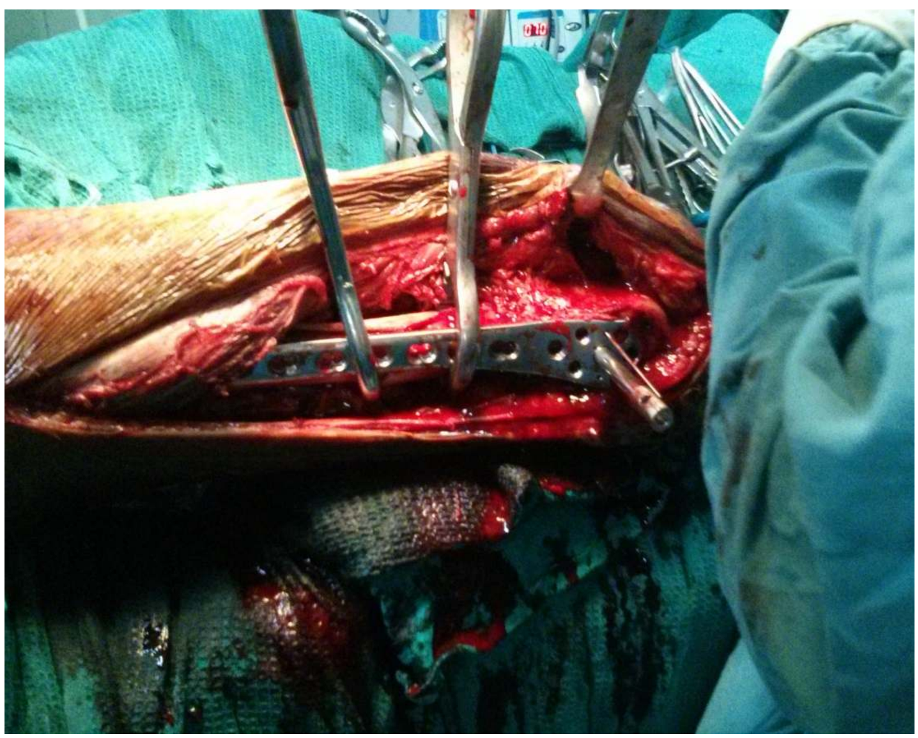
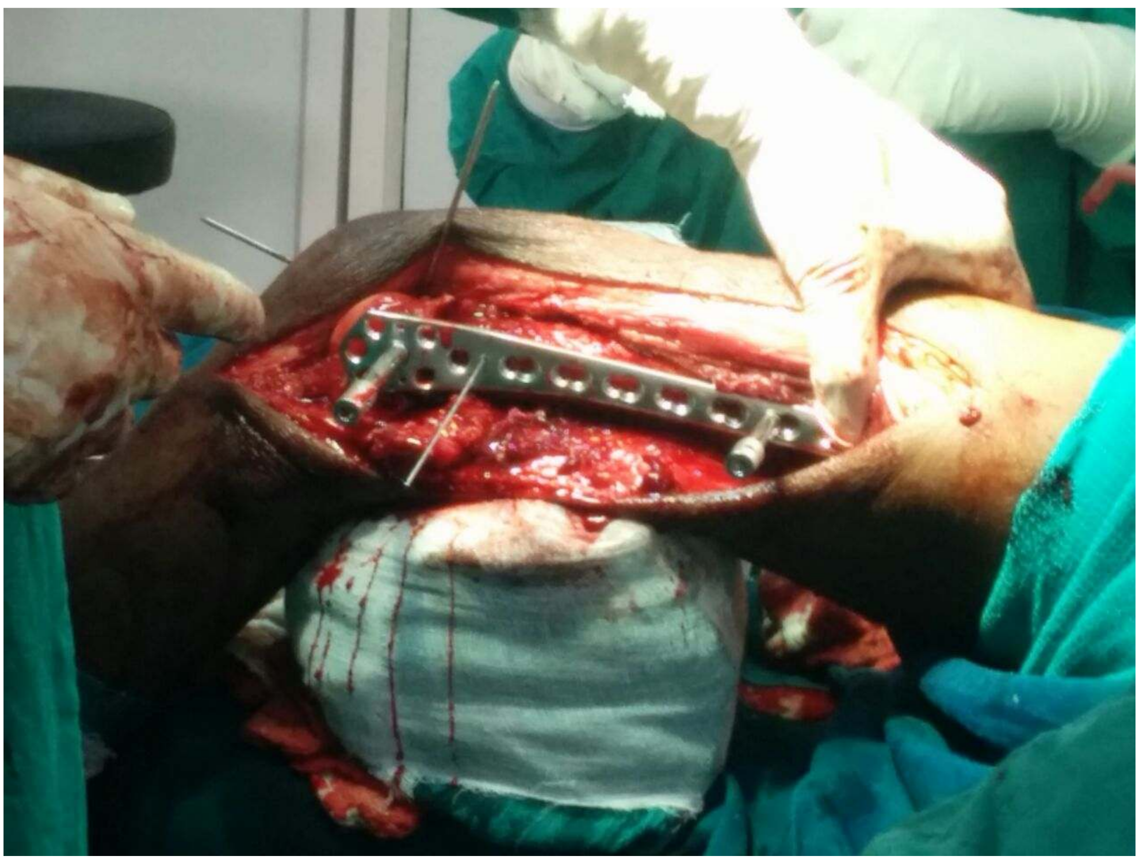


PLATE FIXATION

Under c arm control and after achieving perfect intraarticular reduction using with reduction forceps and with or without k wires if needed, the fracture is fixed using a locking compression plate of sufficient length as per principle first 6.5 mm condylar locking screw is inserted and then 5 mm locking cancellous screws distally and 5 mm locking cortical screws proximally. Bone grafting was done in cases with severe comminution and bone loss and articular reconstruction using Herbert screws for two cases with Hoffa fractures were used



CLOSURE: The split vastuslateralis is closed using interrupted absorbable sutures, the fascia lata is closed using continuous sutures, and the skin is closed in layers with an absorbable suture material and surgical staples over a no. 14 suction drain.

POST OPERATIVE CARE AND REHABILITATION

Postoperative care in the form of intravenous broad spectrum antibiotics and periodic changes of dressing were done, suction drain was removed at 48 hours in all the patients and sutures/staples were removed at the 12th postoperative day.

Proper postoperative care and rehabilitation is done to ensure the attainment of satisfactory range of motion, strength and function of the knee joint.

Rehabilitation was ordered for each patient as the fracture types and the strength of the fixation and the quality of the patient's bone varied with each patient. If the fracture fixation was stable, then therapy was started early. The most useful knee range was obtained in the first few weeks postoperatively

Static quadriceps exercises and hamstring strengthening exercises were started from the 2nd postoperative day onwards. Gentle hip and ankle mobilisation was encouraged. Knee active mobilisation exercises were started as pain tolerated from the 2nd day onwards.

Non weight bearing with crutches or walker support was initiated in the first week if the fixation was stable. Partial weight bearing was allowed at 8 weeks, full weight bearing was allowed only after evidence of radiological evidence of union at the fracture site.

All patients were followed up regularly and evaluated for fracture healing, any change in alignment or screw breakage by assessing the patient clinically and radiologically every two months.

Clinical union was defined as a painless fracture site during full weight bearing. Radiological union was defined as bridging trabeculation across the fracture site on three of four cortices.

OUTCOME MEASUREMENT

Functional and radiological assessment of the knee. Functional assessment is by the Neers rating system. Radiological outcome is assessed by serial x rays

NEER'S RATING SYSTEM

CHARACTER	SCORE	DEFINITION
PAIN	4	No pain in all range of motion
	3	Pain, with normal daily activity
	2	Minimal activity gives pain
	1	Pain at rest
MOVEMENTS	4	Flexion more than 120º: no FFD
	3	Full extension, flexion 90º to 120º
	2	Loss of extension less than 10º:flexion 70º to 90º
	1	Flexion less than 60º
FUNCTION	4	Full weight bearing , normal gait , no functional impairment
	3	Limp, no restriction of activity
	2	Requires walking aid
	1	Cannot walk
SHORTENING (cm)	4	0-0.5
	3	0.5-2.5
	2	2.5-5
	1	>5 cm
ANGULATION(in degrees)	4	None
	3	<10º
	2	10-15º
	1	>15º

RESULT	SCORE
EXCELLENT	16-20
GOOD	12-16
FAIR	8-12
FAILURE	4-8

RATING	MOTION	ANGULATION	PAIN	SHORTENING	FUNCTIONAL ABILITY
EXCELLENT	Full extension, Flexion 90 -120	none	none	None	Full weight bearing, normal gait
GOOD	Full extension	<10º	Pain present, normal daily activity	<2.5cms	Limping present, no restriction of activity
FAIR	Loss of extension <10, flexion 70-90	10-15º	Pain with minimal activity	2.5-5 cms	Requires walking aid
FAILURE	Flexion <60	>15º	Pain at rest	>5 cms	Cannot walk

RESULTS

This series consists of 14 cases fractures of the distal femur treated by open reduction and internal fixation using locking compression plates. The following observations were made from the study

Age and sex distribution

In our study almost both sex were equally involved but incidence in males were more as mentioned in table 1.1 whereas majority of patients were aged more than 40 years with eldest being 85 years and youngest being 25 years.

TABLE 1.1

GENDER DISTRIBUTION

GENDER	NUMBER	PERCENTAGE
MALE	**8**	**57**
FEMALE	**6**	**43**
TOTAL	**14**	**100**

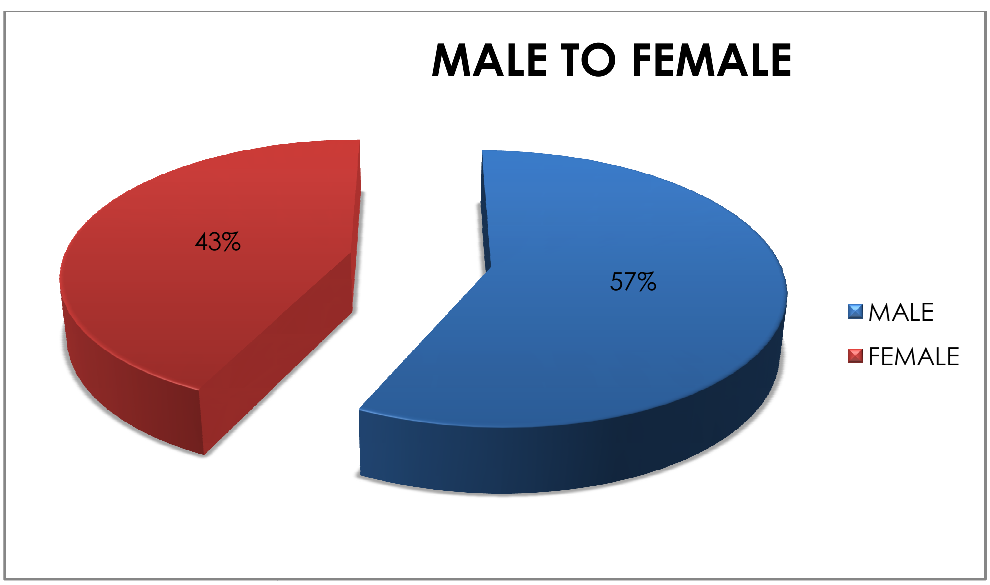


TABLE 1.2

AGE DISTRIBUTION

AGE	NUMBER	PERCENTAGE
25-40	**4**	**28.57**
41-60	**5**	**35.71**
61-75	**5**	**35.71**
>76	**1**	**7.14**
TOTAL	**14**	**100**

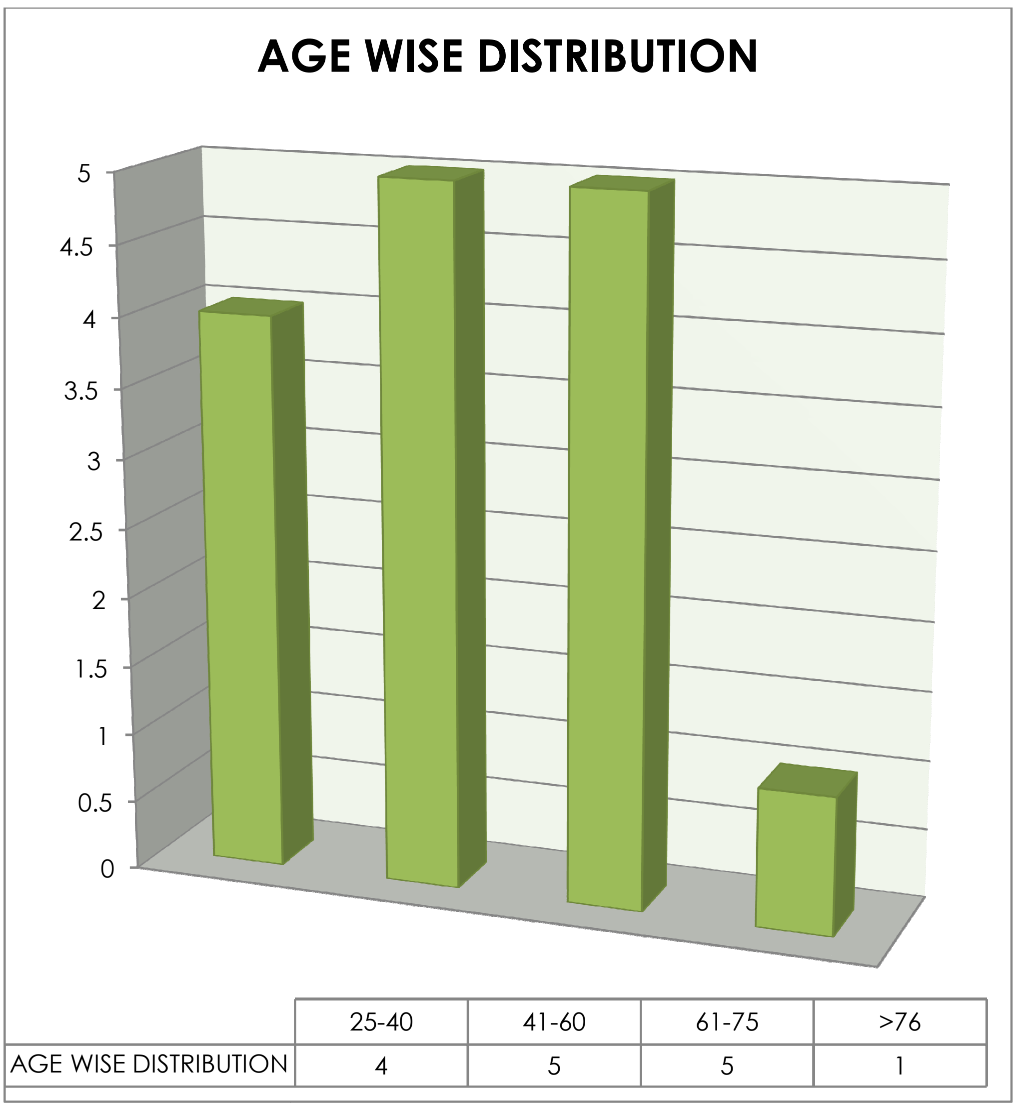


TABLE 1.3

SIDE DISTRIBUTION

SIDE	NUMBER	PERCENTAGE
RIGHT	**10**	**72**
LEFT	**4**	**28**
TOTAL	**14**	**100**

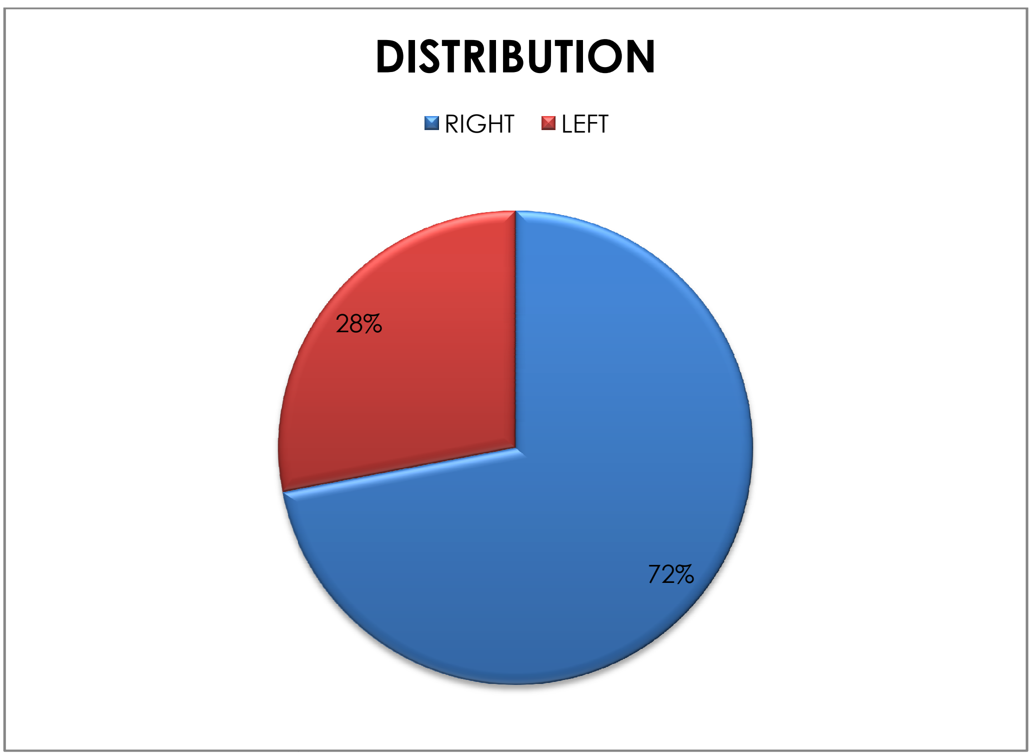


TABLE 1.4

MECHANISM OF INJURY

MECHANISM	NUMBER	PERCENTAGE
RTA	13	93
ACCIDENTAL FALL	1	7
TOTAL	14	100

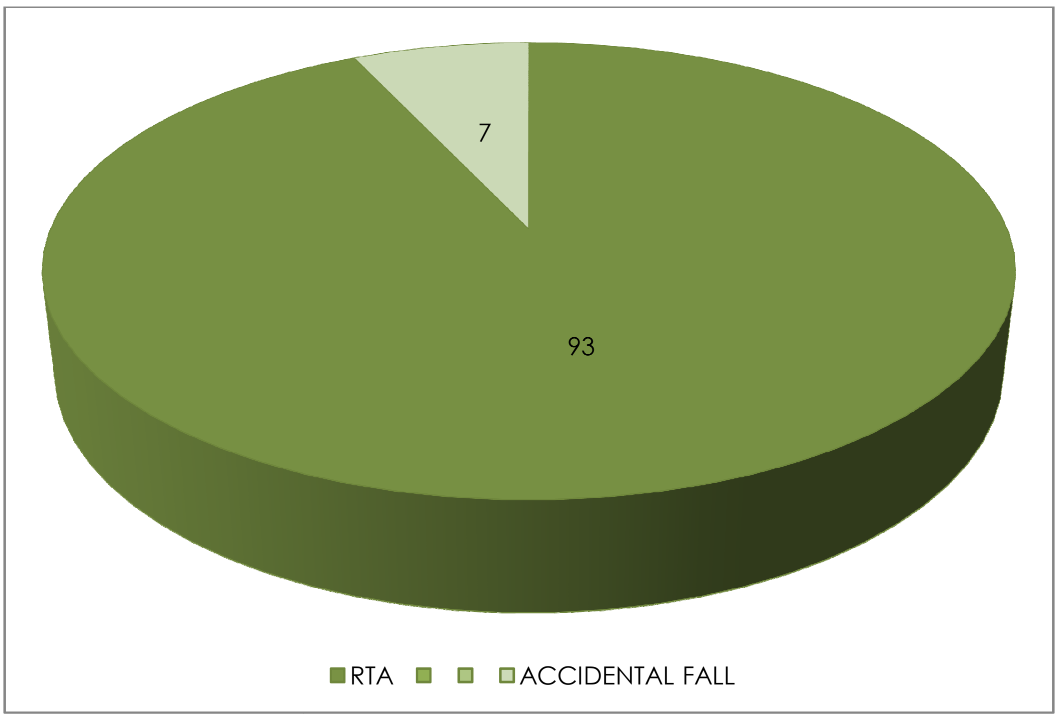


TABLE 1.5

Muller CLASSIFICATION OF THE FRACTURES

TYPE	NUMBER	PERCENTAGE
A 1	0	-
A 2	2	14
A3	6	42
C1	1	7.14
C2	1	7.14
C3	4	28.57
Total	14	100

TABLE 1.6

ANALYSIS OF OUTCOME BASED ON NEERS CRITERIA

GRADING	NUMBER	PERCENTAGE
EXCELLENT	2	14
GOOD	8	58
FAIR	1	7.14
FAILURE/POOR	1	7.14

TABLE 1.7 COMPLICATIONS

COMPLICATION	NUMBER	PERCENTAGE
1.KNEE STIFFNESS	12	86
2.INFECTION	2	14
3.NONUNION	1	7
4.BENT IMPLANT	0	-
5.SHORTENING	3	21

Clinical picture of case with infection

DISCUSSION

This series consists of 14 cases of closed and open fractures of the distal femur treated by open reduction and internal fixation/MIPPO using locking compression plates. There is no single surgical implant that can be used for all distal femur fractures.

In this study, out of the 14 patients, 8 were males and 6 were female . Most of the patients in this study were old patients in the age group 50-85 yrs. The Main cause of injury in this study is attributed to high energy trauma and all patients presented within 12 hours of injury. The side distribution in this study showed marginally more number of persons with fractures on the right side than on the left andWe could find no specific reason for this data.

One of the patients had open fracture both bone leg on ipsilateral which was treated with external fixation. one patients had associated fracture , one patient had an associated fracture of patella on same side. One patient died during the course of this study. one patients in this study we lost up follow up.

In this study 13 patients were injured as result of a VA (Vehicular Accident) which included both two wheelers and four wheelers or drunk and drive. And only one patient sustained injury due to accidental fall and53% of the cases were Muller type A and 47% were type C . and for three patients MIPPO technique was followed.

In our study in most of cases long working length was followed but in four patients short working length was used but we had no implant failure among these cases.

Two patients had associated Hoffa fracture and three patients had open fracture out of which for one patient wound debridement and knee spanning external fixator was applied and surgery was delayed till wound healed well without residual infection and

And the patients who had associated Hoffa fracture the articular reconstruction was carried using Herbert screws and by countersinking the 4mm cancellous screws.

Bone grafting was done for three patients the shortest follow up period was 3 months and longest period was 12 months Complications included postoperative knee stiffness in almost 84 % of the patients.and 15% of the cases got infected. There was no cases of implant failure in our study .

Limb length discrepancy in the form of shortening less than 2.5 cm was seen in two patients . In this study by the analysis of the results using the Neer's rating criteria taking into account pain, knee range of motion, angulation and functional ability, there were two cases with excellent results, 7 cases with good results and one cases with failure results. Failure case which we had associated open fracture both bone leg and may that may be result of failure result as the patient had post op infection and was not allowed to weight bear.

When we compared our study with other studies through out the world then following result were obtained as shown in table

The good outcome seen in our study can be attributed to more of Type A fractures, which usually show favorable results. Most of the series above have equal or higher number of Type C fracture but the small sample size can be used only as Level III evidence in Evidence based medicine**.**

In our study, radiological union was seenat an average of 16 weeks which iscomparable to study of LCP by Kayali et al in 2005, that averages 15 weeks. Overallresults were excellent in 2 out of 14 cases and were satisfactory in remaining casesexcept one.

We had 69% good to excellent outcome as per Neer Score in our study, compared to Ketterel et al (90%) and Hann et al (86%).

Study series	Year	number of fracture	% open fractures	% nonunion	% delayed union	% needing bone graft	% hardware failure	Average healing time	average follow up
Schandelmaier et al	2001	54	19	2	6	11	9	13	6
Fankhauser et al.	2004	30	47	0	3	20	20	12	20
Kregor et al.	2004	103	34	2	-	10	5	-	14
Markmiller et al	2004	20	-	10	0	10	0	14	12
Weight and Colling et al	2004	22	27	0	0	0	0	13	10
Schutz et al	2005	52	32	4	12	19	6	-	12
Vallier et al	2006	46	54	9	15	20	13	-	12
Kayali et al.	2007	27	26	0	-	4	7	15	26
Gaines et al.	2008	109	41	8	-	-	-	-	6
Henderson et al	2011	70	26	20	-	13	8	12	20
Our study	2013	13	23	7	--	23	-	4	6

CONCLUSION

This prospective study using LCP for distal femoral fractures in a tertiary referral centre gives an insight into the incidence of distal femoral fractures. since 2001 it is there for clinical use and it has revolutionized internal plate fixation as this combines two different principles of internal fixation, each of which gives the surgeon to access the entire range of options available for internal fixation, from compression screw osteosynthesis with the principle of absolute stability to biological fixation.To explore its advantage surgeon must know the accurate knowledge of the characteristics of the various principles of internal fixation.

With the availability of anatomically preshaped plates it make easier for surgeon to select from the different combinations possible by prescribing the typical type of internal fixation for each segment of the skeletal system. And this help surgeons to reduce the incidence of complications which were observed in the early years of application of the LCP as a result of violating the principles of osteosynthesis . When lot of options to manage these distal femoral fractures are available it makes difficult to decide but the basic principles of management of intra articular fractures are better addressed with the use of the locking compression plate.

In our study in most of cases long working length was followed but in four patients short working length was used but we had no implant failure among these cases. Fracture of the distal femur are notorious to cause knee stiffness, shortening, delayed union and infection .Rigid internal fixation permits early functional rehabilitation of the patient and decreases the incidence of malunion, non union and loss of fixation.

Knee stiffness and shortening which were the common complications observed in our study which can be tackled by taking the patients for surgery as soon as possible and surgical expertise, meticulous soft tissue handling and vigorous early knee mobilisation.

To conclude, the locking compression plate for distal femur is a safe and effective tool to manage these difficult fractures as we had no incidence of implant failure and delayed union and non-union and revision surgery except that we had knee stiffness as commonest complication , so its implant of choice in dealing with osteoporotic distal femur fracture as majority of patients in our study had osteoporotic bones. Our study was limited by its small sample size and time duration but it brings the important message that fixation in osteoporotic bone in a geriatric population does present great difficulty. Randomized controlled study is necessary to address the issue as to whether LISS is superior to traditional implants.

BIBLIOGRAPHY

1. Thomas P Reudi, Richard E Buckley, Christopher G Moran. A O Principles of Fracture Managament. 2nd edition. Switzerland: A O Publishing; 2007.

2. O Martinet, J Cordey, Y Harder, A Maier, M Buhler, G E Barraud. Epidemiology of Fracture of Distal Femur. Injury2000; 31: 62-63.

3. Cory A Collne, Donald A Wiss. Rockwood and Green Fracture in adults. 7th edition.Philadelphia: LWW; 2009.

4. Wilson JN. Watson Jone's: Fractures and joint injuries. 6thed, pg. 1003-070, 1982.

5. Charnley John. The closed treatment of common fractures. 3rded, Pg. 197-204.

6. Stover M. Distal femoral fractures: Current Treatment, Results and Problems. Injury2001; 32(3): 3-13.

7. Egol KA, Kubiak EN, Fulkerson E, Kummer FJ, Koval KJ. Biomechanics of LockedPlates and Screws. J Orthop Trauma 2004 Sept; 18(8): 488-493.

8. Rockwood CA, Green DP. Fractures in Adult. 4thedn, Philadelphia: LWW;1996.

9. Venable CS, Stuck WG, Beach A. The Effects on Bone of the Presence of Metals:Based on electrolysis. Ann Surg1937 Jun; 105(6): 917-938.
10. Stewart MJ, Sisk TD, Wallace SLJr. Fractures of the Distal Third of Femur – AComparison of methods of treatment. JBJS Am 1966 June; 48-A(4): 784-807.
11. Banks HH. The Healing of IntraarticularFractures.ClinOrthopRelat Res 1965 May-Jun; 40:17-29.
12. Neer CS II, Grantham SA, Shelton ML. Supracondylar Fracture of the Adult Femur –A Study of One Hundered and Ten Cases. JBJS Am 1967 June; 49-A(4): 591-613.
13. Anderson RL. Conservative treatment of Fractures of the Femur. JBJS Am1967 Oct; 49-A(7): 1371-375.
14. Wardlaw D, McLauchlan J, Pratt DJ, Bowker P. Biomechanical study of Cast-Brace treatment of Femoral Shaft Fractures. JBJS Br 1981; 63-B(1): 7-11.86.
15. Olerud S. Operative treatment of Supracondylar Fractures of Femur – Technique andResults in Fifteen Cases. JBJS 1972 Jul; 54-A(5): 1015-1032.
16. Brown A, D'Arcy JC. Internal Fixation for Supracondylar Fractures of the Femur inthe Elderly patient. JBJS 1971 Aug; 53-B(3): 420-424.

17. Enneking WF, Horowitz.M. The Intra-Articular Effects of Immobilization on theHuman Knee. JBJS Am 1972 Jul; 54-A(5): 973-985.

18. Connolly JF, King P. Closed Reduction and Early Cast-Brace Ambulation in theTreatment of Femoral Fractures. JBJS Am 1973 Dec; 55-A(8): 1559-1599.

19. Pavel A, Smith RL, Ballard A, LarsenAJ. Prophylactic Antibiotic in CleanOrthopaedic Surgery. JBJS Am 1974 June; 56-A(4): 777-782.

20. Schatzker J, Home G, Waddell J. TheToronto Experience with SupracondylarFactures of Femur. Injury 1974 Nov; 6(2): 113-128.

21. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousandand twenty-five open fractures of long bone - Retrospective and prospective analysis.JBJS Am 1976 Jun; 58-A(4): 453-58.

22. Zickel RE, Fietti VGJr, Lawsing JF, Cochran GV. A new intramedullary fixation device for the distal third of femur. ClinOrthopRelat Res 1977 Jun; 125: 185-91.

23. Zimmerman AJ. Intraarticular Fracturesof Distal Femur.OrthopClinNorthAm 1979 Jan; 10(1): 75-80.

24. Kolmert L, Wulff K. Epidemiology and Treatment of Distal Femoral Fracturesin Adults. ActaOrthopScand 1982; 53: 957-962.

25. Mize RD, Bucholz RE, Grogan DP. Surgical treatment of displaced, comminutedfractures of distal end of femur. JBJS Am 1982 July; 64-A(6): 871-879.

26. Papagiannopoulos G, Clement DA. Treatmentof Fractures of the Distal Third ofFemur – A Prospective Trial of the Derby Intramedullary Nail. JBJS (Br) 1987 Jan;69-B(1): 67-70.87.

27. Yang RS, Liu HC Liu TK. Supracondylar fractures of the femur. J Trauma 1990 Mar;30(3): 315-19.

28. Sanders R, Swiontowski M, Rosen H, Helfet D. Double-Plating of Comminuted,Unstable Fractures of the Distal Part of the Femur. JBJS 1991 Mar; 73-A(3): 341-346.

29. Shewring DJ, Meggitt BF. Fractures of Distal Femur Treated with AO DynamicCondylar Screw. JBJS 1992 Jan; 74-B(1): 122-125.

30. Butt MS, Krikler SJ, Ali MS. Displaced Fractures of the Distal Femur in ElderlyPatients – Operative versus Non-Operative Treatment. JBJS (Br) 1995 Jan; 77-B(1):110-114.

31. Krettek C, Schandelmaier P, Miclau T, Tscherne H. Minimally Invasive Percutaneous.

32. Plate Osteosynthesis(MIPPO) using the DCS in Proximal and Distal FemoralFractures. Injury 1997; 28(1): 20-30.Guy P, Krettek C, Mannss J, Whittall KP, Schandelmaier P, Tscherne H. CT-basedanalysis of the geometry of the distal femur. Injury 1998; 29(3): 16- 21.

33. Maier A, Cordey J, Regazzoni P. Prevention of malunions in the rotation of complexfractures of the distal femur treated using the Dynamic Condylar Screw (DCS): Ananatomical graphic analysis using computed tomography on cadaveric specimens.Injury 2000; 31(2): 63-69.

34. Kregor PJ, Stannard J, Zlowodzki M, ColePA, Alonso J. Distal femoral fracturefixation utilizing the Less Invasive Stabilization System(L.I.S.S.): The technique andearly results. Injury 2001; 32(3): 32-47.

35. .Schandelmaier P, Partenheimer A, Koenemann B, Grun OA, Krettek C. Distalfemoral fractures and LISS stabilization. Injury 2001; 32(3): 55-63.

36. Marti A, Fankhauser C, Frenk A, CordeyJ,Gasser B. Biomechanical Evaluation ofthe Less Invasive Stabilization System forthe Internal Fixation of Distal FemurFractures. J Orthop Trauma 2001; 15(7): 482-487.88.

37. Stoffel K, Dieter U, Stachowiak G, Gachter A, Kuster MS. Biomechanical testing ofthe LCP - how can stability in locked internalfixators be controlled?. Injury 2003;34(2): 11-19.

38. Markmiller M, Konrad G, Sudkamp N. Femur – LISS and Distal Femur Nail forFixation of Distal Femoral Fractures. ClinOrthop and Relat Res 2004; 426: 252-257.

39. Pearse EO, Klass B, Bendall SP, Railton GT. Stanmore Total Knee Replacementversus Internal Fixation for Supracondylar Fractures of the Distal Femur in ElderlyPatients. Injury 2005 Apr; 36: 163-168.

40. Zlowodzki M, Bhandari M, Marek DJ, ColePA, Kregor PJ. Operative Treatment ofAcute Distal Femur Fractures: Systematic Review of Two Comparative Studies and45 Case Series. J Orthop Trauma 2006 May; 20(5): 366-371.

41. Vallier HA, Hennessey TA, Sontich JK, Patterson BM. Failure of LCP condylar platefixation in the distal part of the femur - A report of six cases. JBJS Am 2006Apr;88(4): 846- 853.

42. Ahmad M, Nanda R, Bajwa AS, Candal-Couto J, Green S, Hui AC. Biomechanicaltesting of the Locking Compression Plate:When does the distance between bone andimplant significantly reduce construct stability?. Injury 2007; 38: 358-364.

43. Higgins TF, Pittman G, Hines J, BachusKN. Biomechanical Analysis of Distal Femur Fracture Fixation: Fixed-Angle Screw-Plate Construct Versus Condylar BladePlate. J Orthop Trauma 2007 Jan; 21(1): 43-46.

44. Henderson CE, Lujan T, Bottlang M, Fitzpatrick DC, Steve MM, Marsh JL.Stabilization of distal femur fractures withintramedullary nails and locking plates:differences in callus formation. Iowa Orthop J 2010; 30: 61-68.

45. Taylor DW, Bohm KC, Taylor JE, Gross AE. Use of fresh osteochondral allograft inrepair of distal femur after trauma. MJM 2010; 13(1): 22-27.89.

46. Henderson CE, Lujan TJ, Kuhl LL, BottlangM, Fitzpatrick DC, Marsh JL. HealingComplications Are Common After Locked Plating for Distal Femur Fractures. ClinOrthopRelat Res 2011 June; 469(6): 1757-1765.

47. Hierholzer C, Christan von Ruden, Potzel T, Woltmann A, Buhren V. Outcomeanalysis of Retrograde Nailing and Less Invasive Stabilization System in DistaFemoral Fractures: A retrospective analysis. Indian J Orthop 2011 May-Jun; 45(3):243-250.

48. Muckley T, Wahnert D, HoffmeierKL,Geert von Oldenburg, Frober R, HofmannGO. Internal Fixation of Type-C Distal Femoral Fractures in Osteoporotic Bone –Surgical Technique. JBJS Am 2011 Mar; 93(1): 40-53.

49. Thompson JC. Netters Concise Atlas of Orthopaedic Anatomy.1st edn.Philadelphia:Elsevier Inc;2001.

50. Agur Anne, Dalley AF. Grants AtlasofAnatomy. 12th edn: LWW; 2009.

51. Whittel AP, Wood GW, Canale T. Cambells Operative Orthopaedics. 11th edn:Elsevier Inc; 2008.

52. Forster MC, Komarsamy B, Davison JN. Distal femoral fractures: A review of fixation methods. Injury 2006 Feb; 37: 97-108.

53. RitaKulkarni. Gait analysis.Textbook of Orthopaedics and Trauma.2nded. 2008.

54. Kubiak EN, Fulkerson E, Strauss E, EgolKA. The Evolution of Locked Plates. JBJS2006; 88-A(4): 189-200.

55. Frigg R. Locking Compression Plate (LCP) – An osteosynthesis plate basedon the Dynamic Compression Plate and the Point Contact Fixator (PC-fix).Injury 2001 Sept; 32(2): 63-66.

56. Christopher E. Henderson, Lori L. Kuhl, Daniel C. Fitzpatrick. HealingComplications Are Common After LockedPlating for Distal Femur Fractures.ClinorthopRelat Res 2011; 469:1757-176590.

57. Giannoudis PV, Schneider E. Principles of fixation of osteoporotic fractures. JBJS Br2006 Oct; 88(10): 1272-1278.

58. Sommer C, Babst R, Muller M, Hanson B.Locking Compression Plate Looseningand Plate Breakage – A Report of Four Cases. J Orthop Trauma 2004 sept; 18(8):571-577.

59. Schandelmaier P, Partenheimer A, Koenemann B, Grun OA, Krettek C. Distalfemoral fractures and LISS stabilization. Injury 2001;32(suppl 3):SC55–SC63.

60. K. Kolb, P. Grutzner, H. Koller, C.Windisch, F. Marx, W. Kolb. The condylarplate for treatment of distal femoral fractures: A long-term follow-up study.Injury 2009; 40: 440-448.

61. (James E Anderson. Grant's Atlas of Anatomy. 8th Edition,Anastomosis Around Knee, 4-54, 4-55; Knee Joint, 4-56, 4-57, 4-60.).

62. Tees JD. Fracture of lower end of femur. Am J Surg 1937;38:656659.

63. BohlerL. The Treatment of fractures. New York: Grune and Stratton;1956.

64. SlatisP.,Ryoppy S.,Huttinen V :AO osteosynthesis of fractures of the distal third ofthe femur.ActaOrthop Scand1971;42:162-172.

65. Tscherne H.,TrentzO.:Recent injuries of the femoral condyles.Langenbecks ArchChir1977;345:396-401.

66. BeingessnerD,MoonE,BareiD,Morshed S.J Trauma. 2011 sept; 71 (3): 620-4.

67. YANG Tengheng,ZHONGZhinian,LAOJiyi,et al: Locking compression platein the treatment of distal femur fractures.Jilin Medical Journal 2011-13.

68. Valles JF, Rodríguez FR, Gómez JM:Distal femur fractures. Comparative analysisOf two different surgical treatments.ActaOrtop Mex:2010 Sep-Oct;24(5):324-30.

69. Bottlang M, Lesser M, Koerber J, Doornink J, von Rechenberg B, AugatP,Fitzpatrick DC, Madey SM, Marsh JL. Far cortical locking

can improve healing Of fractures stabilized with locking plates. JBJS Am.2010 Jul7;92(7):1652-60.

70. Kim KJ, Lee SK, Choy WS, Kwon WC, Lee DH ; Surgical Treatment of AO TypeC Distal Femoral Fractures Using Locking CompressionPlate(LCP-DF)JKoreanFract Soc. 2010 Jan ;23(1): 20-25. Korean.

71. F. Winston Gwathmey, Jr, MD, Sean M. Jones-Quaidoo, MD, David Kahler, MD,Shepard Hurwitz, MD and Quanjun Cui, MD;C Distal Femoral Fractures Using Locking CompressionPlate(LCP-DF);J Am AcadOrthopSurg, Distal Femoral Fractures: Current Concepts-Vol 18, No 10, October 2010, 597.

72. Mueller, ME, Allgoewer, M, Willenegger, H. 1965. Technique of Internal Fixation of Fractures. Berlin Heidelberg New York: Springe—Verlag.

73. J Bone Joint Surg Br 2012 vol. 94-B no. SUPP XVIII 46).

74. GAUTIER, E., SOMMER, C.: Guidelines for the clinical application of the LCP. Injury, 34 Suppl. 2: B63-76, 2003.).

75. Cordey J, Borgeaud M, Perren SM. Force transfer between the plate and the bone: relative importance of the bending stiffness of the screws friction between plate and bone. Injury. 2000;31Suppl 3: C21-8.

76. Cordey J, Mikuschka-Galgoczy E, Blumlein H, Schneider U, Perren SM. [Impor-tance of the friction between plate and bone in the anchoring of plates for osteo-synthesis. Determination of the coefficient of metal-bone friction in animal invivo].HelvChirActa. 1979;46:183-7. French.

77. Simon JA, Dennis MG, Kummer FJ, Koval KJ. Schuhli augmentation of plate and screw fixation for humeral shaftfractures: a laboratory study. J Orthop Trauma. 1999;13:196-9.

78. Baumgaertel F, Buhl M, Rahn BA. Fracture healing in biological plate osteosyn-thesis. Injury. 1998;29Suppl 3:C3-6.

79. Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H. Minimally invasive plate osteosynthesis: does percutaneous plating disrupt femoral blood supply less than the traditional technique? J Orthop Trauma. 1999;13:401-6.

80. Perren SM. Evolution of the internal fixation oflong bone fractures. The scientific basis of biological internal fixation: choosing a new balance between stability and biology. J Bone Joint Surg Br.2002;84:1093-110.

MASTER CHART

S. no	Name	Age/ SEX	IP NO	CLASSIFICATION	MOI	DOI	OPEN/ CLOSED	DOS	FOLLOWUP	COMPLICATION	RESULT	KNEERS SCORE
1	KARUPPUSAMY	37/M	76623	C3	RTA	17.12.13	OPEN	10.2.14	7 MONTHS	STIFFNESS	FAIR	9
2	UDHAYKUMAR	45/M	77654	C3	RTA	22.12.13	CLOSED	9.1.14	8 MONTHS	STIFFNESS	GOOD	14
3	RANGATHAL	69/F	53463	C1	RTA	3.9.13	OPEN	26.9.13	PATIENT EXPIRED AFTER 2 MONTHS OF SURGERY	-	-	-
4	SAM ALEXANDER	25/M	53683	C2	RTA	31.8.13	OPEN	23.9.13	LOST FOLLOW UP AFTER 3 MONTHS	INFECTION, STIFFNESS	-	-
5	KUMARASAMY	57/M	49328	A2	RTA	49328	CLOSED	20.3.14	6 MONTHS	STIFFNESS	GOOD	14
6	SUBBAMMAL	65/F	62795	A2	ACC/ FALL	23.8.13	CLOSED	19.9.13	12 MONTHS	STIFFNESS SHOTERNING	GOOD	14

7	RAJENDRAN	40/M	6844	A3	RTA	20.2.14	CLOSED	20.2.14	7 MONTHS	STIFFNESS	GOOD	14
8	THILAGA	50/F	16569	A3	RTA	19.3.14	CLOSED	21.4.14	5 MONTHS	INFECTION, STIFFNESS, NONUNION	FAILURE	8
9	THAVAGNAM	60/M	15084	A3	RTA	12.3.14	CLOSED	24.3.14	6 MONTHS	STIFFNESS	GOOD	16
10	KITTUSAMY	55/M		A3	RTA	15.4.14	CLOSED	5.5.14	4MONTHS	STIFFNESS	EXCE LLENT	17
11	FATHIMA	70/F	31863	C3	ACC FALL	27.5.14	CLOSED	17.6.14	3 MONTHS	STIFFNESS	GOOD	16
12	CHINNABABU	40/M	32372	A3	RTA	29.5.14	CLOSED	26.6.14	3 MONTHS	STIFFNESS	EXCE LLENT	17
13	RAJAMMAL	85/F	37429	C3	RTA	13.6.14	CLOSED	23.6.14	3MONTHS	STIFFNESS	GOOD	15
14	MANTHRAL	65/F	50979	A3	RTA	23.8.13	CLOSE D	19.9.1 3	12 MONTHS	STIFFNESS	GOO D	15

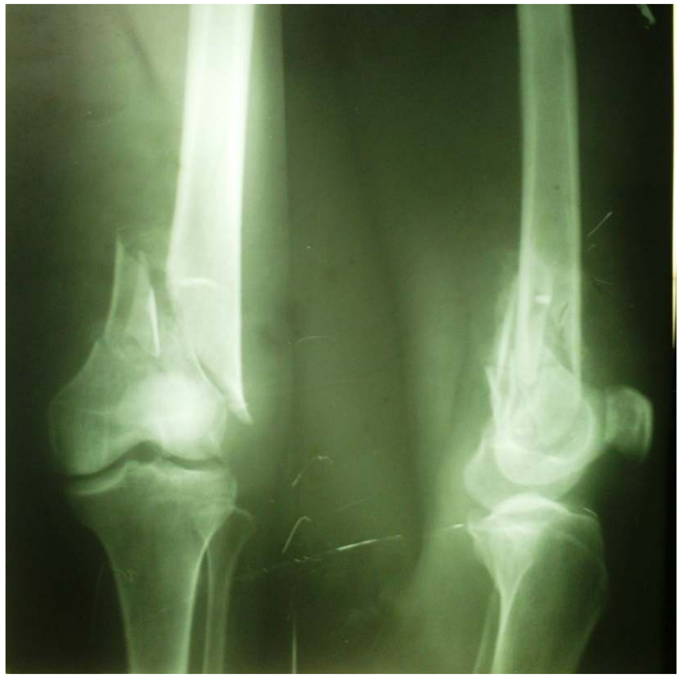
CASE ILLUSTRATIONS

CASE 1-

This 55 years male patient had RTA. On examination he was conscious and oriented and his vitals were stable. Local examination revealed gross swelling and abnormal mobility of the left thigh and leg (fig 11.1).

Clinical photo

X rays of the right thigh with the knee AP and lateral (fig 11.2 and 11.3) views were taken; they revealed an intraarticular fracture of the distal femur with an associated ipsilateral proximal tibia fracture. The type of the fracture was Muller type A2. The patient was initially stabilised and lower tibial pin traction was applied.



Pre op X rays (AP and lateral projections)

He was taken up for surgery on the three weeks post injury . The distal femur was fixed using distal femur locking plate

intra op pictures

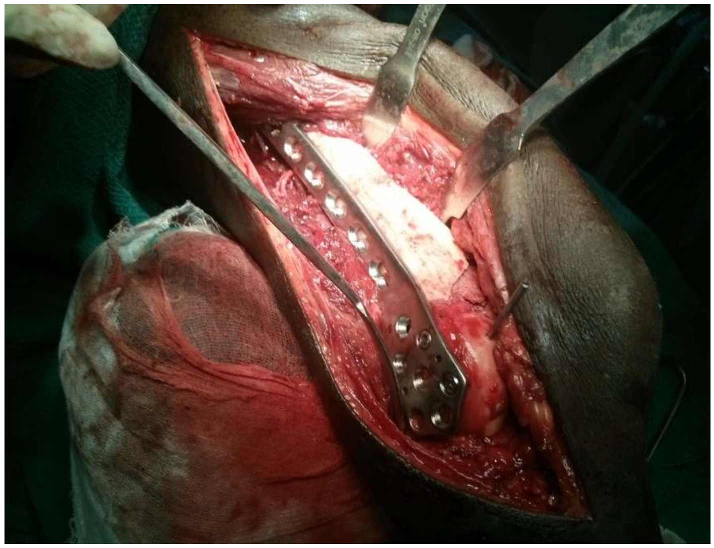
He was doing well in his follow up period with no infection but he had stiffnessFollowing this he went on to union of the distal femur in 4 months but he had only about 45º range of motion at the knee

CASE 2

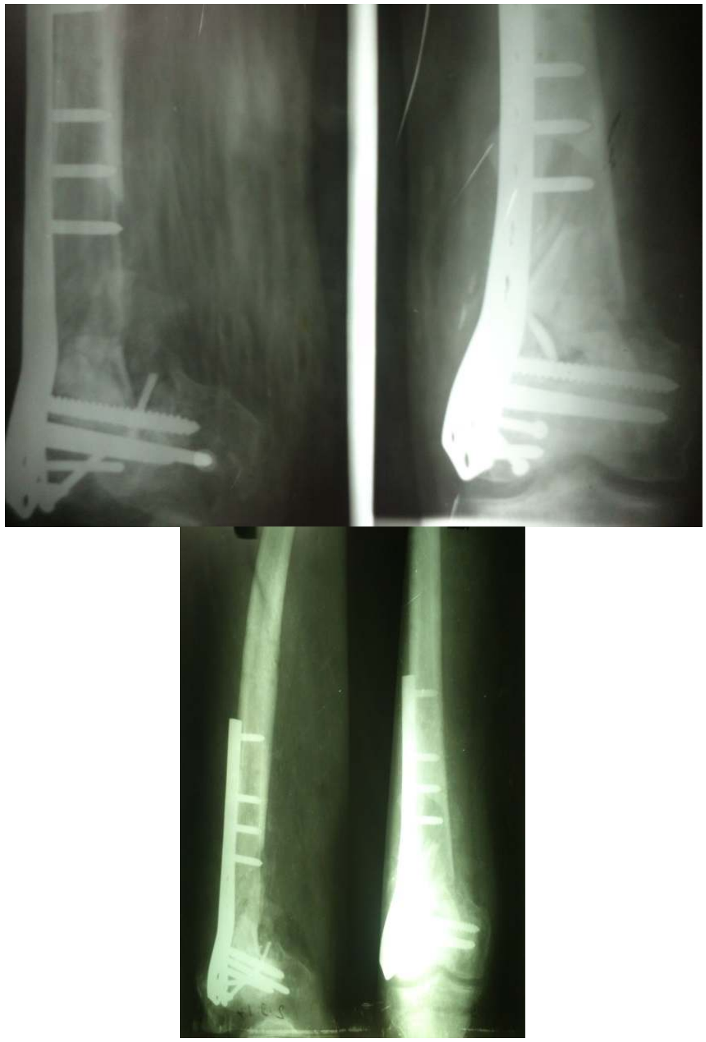
Mr VJ,45 year old male sustained injury due to RTA . He was conscious and oriented and his vitals were stable. Local examination revealed open fracture of distal femur right side . X rays of the right thigh with the knee AP and lateral views were taken,

they revealed an intraarticular fracture of the distal femur. The type of the fracture was Muller type C2. The patient was initially stabilised and lower tibial pin traction was applied.He was taken up for surgery on the 18days following injury.whenOpen reduction was done there was presence of Hoffa fracture which was first reduced and fixed using 4mm cancellous screw and Herbert screws and varus valgus alignment was corrected and fixed using locking plate The plate was locked distally and proximally. The intraoperative findings are shown in figure

Intraoperative picture showing temporary fixation of Hoffa fracture



He was given postoperative intravenous antibiotics and dressings . Physiotherapy in the form of static quadriceps exercises and knee mobilisation exercises were started . Full non weight bearing walking with the help of a walker was advised . He was reveiwed after 8 weeks.He had knee range of motion of 10 degree only follow up Xrays showed evidence of radiological union in the form of callus formation.



Follow up clinical picture

CASE 3

Preopxray **postop xray**

Clinical follow up pictures

Case 4

Preop and post op xray

Clinical follow up pictures

PROFORMA

1. NAME :
2. AGE :
3. SEX :
4. ADDRESS :
5. OCCUPATION :
6. DATE OF INJURY :
7. DATE OF ADMISSION :
8. DATE OF SURGERY :
9. DATE OF DISCHARGE :
10. NATURE OF TRAUMA :
    - RTA
    - FALL FROM HEIGHT
    - ASSAULT

11. MECHANISM OF INJURY :
12. DURATION SINCE INJURY :

GENERAL PHYSICAL EXAMINATION :

- Pulse rate
- Blood pressure
- Spo2
- Respiratory rate
- Pallor Yes/No
- RS examination
- CVS examination
- Presence of associated injury: Yes/No
  If yes, specify

13.LOCAL EXAMINATION

14.RELEVANT INVESTIGATIONS

- X-rays of the distal femur and knee joints AP and LAT Yes/ No
- Additional X-rays of associated injuries Yes/No
- Routine blood investigations Yes/ No
- Renal profile Yes/ No
- HIV, HBsAg Yes/ No
- Chest X-ray / ECG Yes/No

15.DIAGNOSIS

16.TREATMENT Yes/No

First Aid a) Immobilisation of the limb

b) Thomas Splint /POP slab

c) Analgesics

Definitive treatment

a) Relevant investigations and medical fitness for surgery Yes/ No

b) Anaesthesia Spinal/General

c) ORIF with LCP

d) Antibiotic therapy –preop and postop Yes/ No

e) Analgesics Yes/ No

20. COMPLICATIONS :

Intraoperative: a) Difficulty in reduction of fragments Yes/ No

b) Excessive bleeding Yes/No

Postoperative: a) Infection Yes/ No

b)Knee stiffness Yes/ No

c) Non union Yes/ No

d) Hardware failure Yes/ No

21. FOLLOW UP:

Date:

Serial no. of follow up;

Time since surgery:

Clinical Union:

Pain at fracture site	Yes/No
Abnormal Mobility	Yes/ No
Transmission of movements	Yes/ No

Radiological union: Yes/ No

ABBREVIATIONS

1. V.A - VEHICLAR ACCIDENT
2. L.C.P - LOCKING COMPRESSION PLATE
3. D.C.S - DYNAMIC CONDYLAR SCREW
4. C.B.P - CONDYLAR BLADE PLATE
5. M.C.L - MEDIAL COLLATERAL LIGAMENT
6. A.P - ANTEROPOSTERIOR
7. O.R.I.F - OPEN REDUCTION INTERNAL FIXATION
8. P.O.P - PLASTER OF PARIS
9. E.C.G - ELECTROCARDIOGRAM
10. H.I.V - HUMAN IMMUNODEFICIENCY VIRUS
11. T.K.R - TOTAL KNEE REPLACEMENT
12. M.I.P.P.O - MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS
13. F.F.H - FALL FROM HEIGHT
14. C.P.M - CONTINOUS PASSIVE MOBILISATION
15. I.E.C - INSTITUTIONAL ETHICAL COMMITTEE
16. D.C.P - DYNAMIC COMPRESSION PLATE
17. A.O - ARBEITSGEMEINSCHAFT FÜR OSTEOSYNTHESEFRAGEN
18. G.S.H - GREEN SELIGDON HENRY
19. P.C.L - POSTERIOR CRUCIATE LIGAMENT

ஒப்புதல் படிவம்

பெயர் :

பாலினம் :

முகவரி : வயது :

அரசு கோவை மருத்துவக் கல்லூரியில் பொது மருத்துவ துறையில் பட்ட மேற்படிப்பு பயிலும் மாணவர் **மரு. விஜயகுமார். ரா** அவர்கள் மேற்கொள்ளும் "**கோயமுத்தூர் மருத்துவ கல்லூரி மருத்துவமனையில் தொலை, தொடை எலும்பு முறிவில் டிஸ்டல் பீமர் லாக்கிங் பிளேட் அறுவை சிகிச்சை பயன்பாட்டு விளைவு** ஆய்வில் செய்முறை மற்றும் அனைத்து விவரங்களையும் கேட்டுக் கொண்டு எனது சந்தேகங்களை தெளிவுபடுத்திக் கொண்டேன் என்பதை தெரிவித்துக் கொள்கிறேன்.

நான் இந்த ஆய்வில் முழு சம்மதத்துடன், சுய சிந்தனையுடனும் கலந்து கொள்ள சம்மதிக்கிறேன்.

இந்த ஆய்வில் என்னுடைய அனைத்து விபரங்கள் பாதுகாக்கப்படுவதுடன் இதன் முடிவுகள் ஆய்விதழில் வெளியிடப்படுவதில் ஆட்சேபனை இல்லை என்பதை தெரிவித்துக்கொள்கிறேன். எந்த நேரத்தில் அந்த ஆய்விலிருந்து நான் விலகிக் கொள்ள எனக்கு உரிமை உண்டு என்பதையும் அறிவேன்.

இடம் :

கையொப்பம் / ரேகை

நாள் :